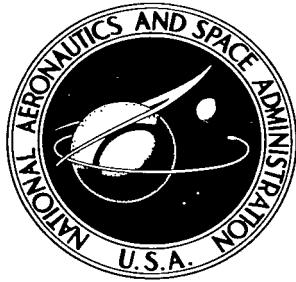


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# THE EMISSIVE POWER OF WATER IN THE INFRARED REGION OF THE SPECTRUM

by M. A. Bramson, I. L. Zel'manovich,  
and G. I. Kuleshova

From *Trudy Glavnay Geofizicheskoy Observatorii*  
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Translation of "Izluchatel'naya sposobnost' vody v infrakrasnoy  
oblasti spektra."

Trudy Glavnay Geofizicheskoy Observatorii imeni A. I. Voyeykova,  
No. 152, pp. 31-67, 1964.

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# THE EMISSIVE POWER OF WATER IN THE INFRARED REGION OF THE SPECTRUM

M. A. Bramson, I. L. Zel'manovich and G. I. Kuleshova

## ABSTRACT

The article presents the results of calculations performed by the "Ural" computer to determine the spectral and spatial distribution of radiation coefficients of water, taking into account the complex coefficient of refraction.

The present work is concerned with the question of evaluating the emissive power of water in the infrared region of the spectrum. This question occurs frequently in various geophysical problems, particularly in the problems concerned with the thermal studies of the sea. Of particular interest are the variations in the emissive power  $\epsilon_\lambda$  as a function of the sighting angle.

A formal solution of the problem may be obtained by direct application of Fresnel equations for the reflection of electromagnetic waves. Indeed, the degree of blackness (emissive power) may be determined from the value of the absorptive power  $\alpha$ . For an absolute blackbody,  $\alpha = 1$ . For any real body  $\alpha < 1$ . If the thickness of the body in the direction of the refracted rays is  $l$ , while the reflection coefficient is  $\rho$ , then

$$\epsilon_\lambda = \alpha_\lambda = (1 - \rho_\lambda) \left( 1 - e^{-\frac{4\pi x_\lambda}{\lambda} l} \right), \quad (1)$$

where  $(1 - \rho_\lambda)$  is the portion of the flux which has penetrated the body;  $\rho_\lambda$  is reflection coefficient;  $\left(1 - e^{-\frac{4\pi x_\lambda}{\lambda} l}\right)$  is the portion of the flux which has penetrated the body and is absorbed in it, and  $x_\lambda$  is the absorption index (ref. 1).

Because even thin layers of water completely absorb the refracted flux in the infrared region of the spectrum, in practical problems this thickness is always sufficiently large, and

$$\epsilon_\lambda \approx 1 - \rho_\lambda, \quad (2)$$

where  $\rho_\lambda$  is determined from the Fresnel equations.

If we distinguish between the rays with the electric vector (direction of oscillations) lying in the incident plane (the p-component of polarization) and lying perpendicular to the plane of incidence (s-component), then the formal expressions for the reflection coefficients, according to the Fresnel theory, will have the following form

$$\rho_{p\lambda} = \frac{\operatorname{tg}^2(\varphi - \psi_\lambda)}{\operatorname{tg}^2(\varphi + \psi_\lambda)}, \quad (3)$$

$$\rho_{s\lambda} = \frac{\sin^2(\varphi - \psi_\lambda)}{\sin^2(\varphi + \psi_\lambda)} \quad (4)$$

and for unpolarized radiation

$$\rho_\lambda = \frac{1}{2} \left[ \frac{\operatorname{tg}^2(\varphi - \psi_\lambda)}{\operatorname{tg}^2(\varphi + \psi_\lambda)} + \frac{\sin^2(\varphi - \psi_\lambda)}{\sin^2(\varphi + \psi_\lambda)} \right], \quad (5)$$

$$\sin \psi_\lambda = \frac{\sin \varphi}{n_\lambda}, \quad (6)$$

where  $\varphi$  is the angle of incidence (the sighting angle),  $\psi_\lambda$  is the refraction angle,  $n_\lambda$  is the relative index of refraction (in the general case it is a complex quantity).

If we take into account equation (6), we may obtain an expression for  $\rho_{p\lambda}$  and  $\rho_{s\lambda}$  as a function only of the incidence angle  $\varphi$

$$\rho_{p\lambda} = \left( \frac{n_\lambda^2 \cos \varphi - \sqrt{n_\lambda^2 - \sin^2 \varphi}}{n_\lambda^2 \cos \varphi + \sqrt{n_\lambda^2 - \sin^2 \varphi}} \right)^2, \quad (7)$$

$$\rho_{s\lambda} = \left( \frac{\cos \varphi - \sqrt{n_\lambda^2 - \sin^2 \varphi}}{\cos \varphi + \sqrt{n_\lambda^2 - \sin^2 \varphi}} \right)^2. \quad (8)$$

The degree of polarization is characterized by the quantity

$$\frac{\rho_p}{\rho_s} \text{ or } p = \frac{\rho_p - \rho_s}{\rho_p + \rho_s} = \frac{\frac{\rho_p}{\rho_s} - 1}{\frac{\rho_p}{\rho_s} + 1}. \quad (9)$$

Since, in the infrared region of the spectrum,  $n_\lambda$  for water is a complex number, the reflection coefficients and the radiation coefficients will also be complex numbers.

The complex nature of the coefficients of refraction of water (with respect to air) in the infrared region of the spectrum prevents a simple physical

interpretation of Fresnel equations (3) - (9), and makes it difficult to obtain concrete data rapidly. It is important, therefore, to obtain equations, graphs and tables. We have attempted to place prime emphasis on this side of the question and have utilized the capabilities of the "Ural" digital computer.

Before proceeding with the results of specific calculations, we introduce the necessary data on the optical constants of water.

The complex index of refraction

$$n_\lambda = n_\lambda (1 - j\chi_\lambda) = n_\lambda - i\kappa_\lambda, \quad (10)$$

where  $\kappa_\lambda = n_\lambda \chi_\lambda$  is the index of absorption,  $\chi_\lambda$  is the coefficient of absorption, and  $n_\lambda$  is the index of refraction.

We note that the coefficient of absorption, equation (1), is

$$a_\lambda = \frac{4\pi\kappa_\lambda}{\lambda}. \quad (11)$$

We shall assume in the future that the quantities  $n_\lambda$  and  $\kappa_\lambda$  are given.

They depend substantially on the wavelength, and their values are determined experimentally. The experiments consist of determining  $\kappa_\lambda$  directly from the attenuation of the radiation after it has passed through a film of definite thickness. The quantity  $n_\lambda$  is obtained from the reflection coefficient for the case of normal incidence, when the differences between the components of the polarization disappear

$$\rho_{\lambda 0} = \left| \frac{n_\lambda - 1}{n_\lambda + 1} \right|^2 = \frac{(n_\lambda - 1)^2 + \kappa_\lambda^2}{(n_\lambda + 1)^2 + \kappa_\lambda^2}, \quad (12)$$

from which

$$n_\lambda = \frac{1 + \rho_{\lambda 0}}{1 - \rho_{\lambda 0}} + \sqrt{\left( \frac{1 + \rho_{\lambda 0}}{1 - \rho_{\lambda 0}} \right)^2 - 1 - \kappa_\lambda^2}, \quad (13)$$

$$\kappa_\lambda = \frac{a_\lambda \lambda}{4\pi}. \quad (14)$$

Table 1 shows the optical properties of liquid water on the basis of references 2 and 3, and of calculations in accordance with the corresponding equations.

The table is illustrated by figures 1-3. The dots represent less reliable data (ref. 1). In references 2 and 3 the data of various investigations are used, including the classical experiments of Rubens and Ladenburg, with appropriate corrections and averaging to suit the conditions of the experiment.

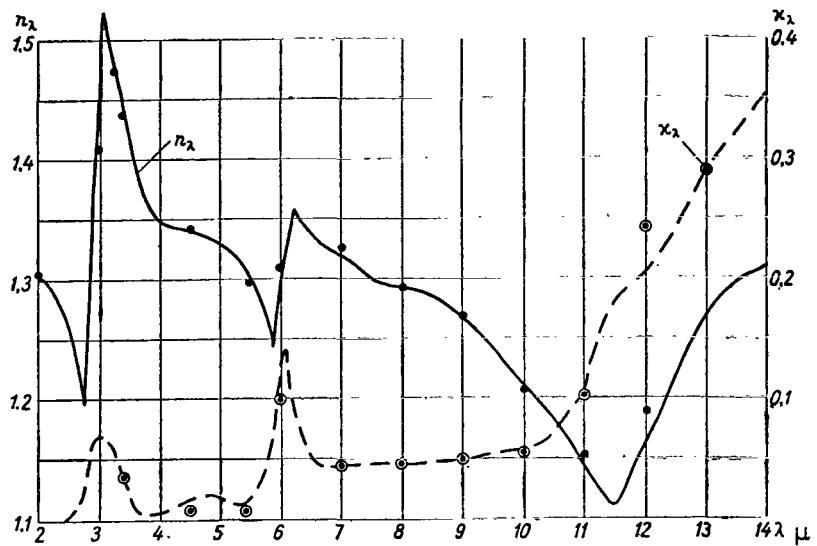


Figure 1. Real and imaginary components of index of refraction of water in infrared region of spectrum.

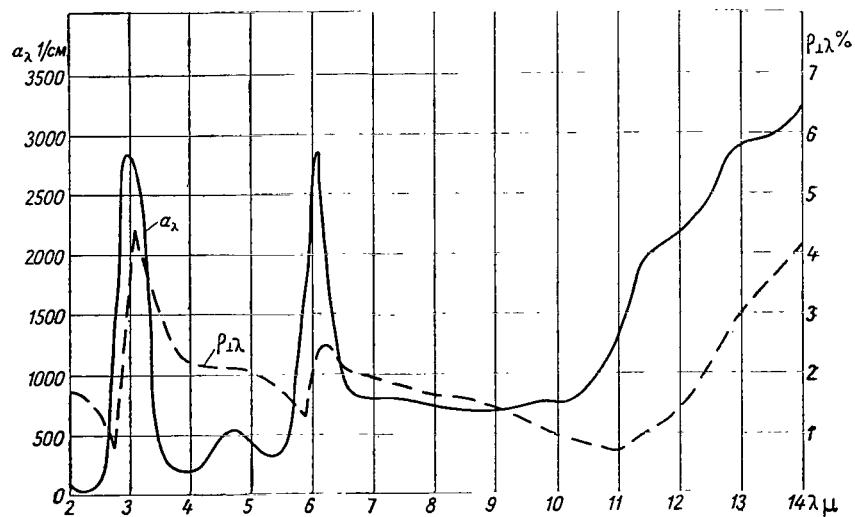


Figure 2. Absorption coefficient and normal reflection coefficient of water in infrared region of spectrum.

The spectral distribution of the extreme points is somewhat different from the one given in the early works of Rubens.

The most important of these are: the maxima - 3.07, 6.20, 17.1  $\mu$ ; the minima 2.74, 5.85, 11.47  $\mu$ .

TABLE 1. OPTICAL CHARACTERISTICS OF LIQUID WATER.

$\lambda \mu$	$\rho_{\lambda 0}$	$a_{\lambda} \frac{1}{\text{cm}}$	$n_{\lambda}$	$x_{\lambda}$	$  n_{\lambda}  $	$\varphi_{B_{\lambda}}$	$\epsilon_{\lambda 0}$	$\rho_{\lambda 0} (\text{calc.})$
1,00	0,0166	0,4396	1,326	$0,0035 \cdot 10^{-3}$	1,32600	52°58' 42"	0,980357	0,016642
1,05	0,0165	0,3708	1,325	$0,0031 \cdot 10^{-3}$	1,32500	52 57 27	0,980460	0,015640
1,10	0,0164	1,9410	1,324	$0,0017 \cdot 10^{-3}$	1,32400	52 56 12	0,980564	0,014636
1,20	0,0163	1,2660	1,323	$0,0121 \cdot 10^{-3}$	1,32300	52 54 54	0,980667	0,019333
1,30	0,0161	1,2463	1,321	$0,0129 \cdot 10^{-3}$	1,32100	52 52 27	0,980872	0,019128
1,40	0,0610	11,656	1,320	$0,0130 \cdot 10^{-2}$	1,32000	52 58 42	0,980900	0,019100
1,50	0,0188	26,125	1,318	$0,0312 \cdot 10^{-2}$	1,31800	52 48 41	0,981188	0,018812
1,60	0,0187	8,792	1,316	$0,0112 \cdot 10^{-2}$	1,31600	52 46 11	0,981383	0,018617
1,70	0,0185	7,978	1,315	$0,0108 \cdot 10^{-2}$	1,31500	52 44 55	0,981485	0,018515
1,80	0,0182	9,973	1,312	$0,0143 \cdot 10^{-2}$	1,31200	52 41 08	0,981789	0,018211
1,90	0,0179	53,756	1,309	$0,0814 \cdot 10^{-2}$	1,03900	52 37 20	0,982091	0,017909
2,00	0,0174	89,804	1,304	$0,0140 \cdot 10^{-1}$	1,03400	52 30 59	0,982590	0,017410
2,20	0,0163	29,114	1,293	$0,0051 \cdot 10^{-1}$	1,29300	52 16 54	0,983672	0,016328
2,40	0,0147	52,626	1,276	$0,0101 \cdot 10^{-1}$	1,27600	51 54 42	0,985294	0,014706
2,50	0,0137	100,982	1,265	$0,0201 \cdot 10^{-1}$	1,26500	51 40 23	0,986311	0,013689
2,60	0,0125	250,432	1,252	$0,0518 \cdot 10^{-1}$	1,25200	51 23 06	0,987473	0,012527
2,70	0,0096	851,190	1,216	0,0183	1,21600	50 34 02	0,990431	0,009569
2,74	0,0075	1251,35	1,187	0,0273	1,18732	49 53 41	0,992534	0,007466
2,77	0,0090	1650,38	1,206	0,0364	1,20655	50 20 52	0,991010	0,008990
2,80	0,0141	2198,0	1,266	0,0490	1,26694	51 42 57	0,985759	0,014241
2,85	0,0200	2547,2	1,324	0,0578	1,32503	52 57 30	0,979957	0,020043
2,90	0,0248	2759,4	1,367	0,0637	1,36848	53 38 33	0,075254	0,024746
2,95	0,0287	2852,4	1,401	0,0670	1,40261	54 30 46	0,971350	0,028650
3,00	0,0340	2847,4	1,446	0,0680	1,44760	55 21 48	0,966006	0,033994
3,02	0,0390	2811,0	1,453	0,0683	1,45461	55 29 34	0,965148	0,034852
3,07	0,0439	2789,6	1,525	0,0682	1,52654	56 46 20	0,956071	0,043929
3,10	0,0340	2759,1	1,517	0,0681	1,51833	56 37 50	0,957109	0,042891
3,16	0,0142	2615,2	1,504	0,0658	1,50545	56 24 21	0,958825	0,041175
3,20	0,0040	2398,1	1,495	0,0611	1,49598	56 14 20	0,960063	0,039937
3,30	0,0365	1408,2	1,471	0,0370	1,47145	55 47 59	0,963451	0,036549

Note: Commas in these tables represent decimal points.

TABLE 1 (continued)

$\lambda \text{ } \mu$	$\rho_{\lambda_0}$	$a_{\lambda} \frac{1}{c.m.}$	$n_{\lambda}$	$x_{\lambda}$	$ n_{\lambda} $	$\varphi_{B_{\lambda}}$	$\epsilon_{\lambda 0}$	$\rho_{\lambda 0} (\text{calc.})$
3,40	0,0337	831,1	1,449	0,0225	1,44952	55°23' 56"	0,966305	0,033695
3,50	0,0305	459,32	1,423	0,0128	1,42340	54 55 37	0,969496	0,030504
3,60	0,0280	272,13	1,402	0,00783	1,40200	54 30 04	0,971980	0,028020
3,70	0,0259	230,83	1,381	0,00619	1,38100	54 05 30	0,974388	0,025612
3,80	0,0236	189,31	1,363	0,00596	1,36300	53 44 00	0,976395	0,023605
3,90	0,0225	190,01	1,353	0,00590	1,35300	53 31 55	0,977487	0,022513
4,03	0,0219	199,45	1,347	0,00642	1,34700	53 24 37	0,978134	0,021866
4,10	0,0218	217,50	1,346	0,00709	1,34600	53 23 23	0,978239	0,021761
4,20	0,0216	260,12	1,344	0,00871	1,34404	53 21 00	0,978449	0,021551
4,30	0,0215	315,26	1,343	0,0108	1,34303	53 19 46	0,978548	0,021452
4,40	0,0214	379,31	1,342	0,0133	1,34205	53 18 33	0,978644	0,021356
4,50	0,0213	457,69	1,341	0,0164	1,34109	53 17 22	0,978734	0,021266
4,60	0,0211	529,66	1,339	0,0194	1,33948	53 15 24	0,978927	0,021073
4,70	0,0210	540,00	1,338	0,0202	1,33770	53 13 13	0,979027	0,020973
4,80	0,0208	521,05	1,336	0,0199	1,33592	53 11 01	0,979240	0,020760
4,90	0,0205	481,80	1,334	0,0188	1,33415	53 08 49	0,979458	0,020542
5,00	0,0202	424,53	1,331	0,0169	1,33110	53 05 18	0,979785	0,020215
5,20	0,0198	345,40	1,322	0,0143	1,32207	52 53 47	0,980732	0,019268
5,30	0,0186	338,87	1,315	0,0143	1,31508	52 45 01	0,981448	0,018552
5,40	0,0180	339,50	1,309	0,0146	1,30907	52 37 26	0,982052	0,017948
5,50	0,0173	397,27	1,302	0,0174	1,30212	52 28 46	0,982733	0,017267
5,60	0,0166	520,23	1,295	0,0232	1,29522	52 19 45	0,983377	0,016623
5,70	0,0157	740,91	1,284	0,0340	1,28445	52 05 51	0,984321	0,015679
5,80	0,0140	1115,2	1,263	0,0515	1,26409	51 39 11	0,985983	0,014017
5,85	0,0125	1401,7	1,242	0,0653	1,24317	51 11 11	0,987511	0,012489
5,90	0,0150	1700,6	1,266	0,0799	1,26852	51 45 24	0,984996	0,015604
6,00	0,0202	2553,4	1,304	0,1220	1,30969	52 38 13	0,979843	0,020157
6,04	0,0216	2852,4	1,312	0,1372	1,31914	53 50 11	0,978344	0,021656
6,10	0,0228	2503,0	1,331	0,1216	1,33617	53 11 19	0,977177	0,022823
6,20	0,0246	1904,0	1,358	0,0940	1,36126	53 41 55	0,975399	0,024601
6,30	0,0234	1531,1	1,352	0,0768	1,35419	53 33 22	0,976561	0,023439
6,40	0,0222	1228,4	1,344	0,0626	1,34547	53 22 44	0,977765	0,022235
6,50	0,0212	1012,5	1,336	0,0524	1,33702	53 12 21	0,978819	0,021181
6,60	0,0205	879,2	1,331	0,0462	1,33181	52 05 55	0,979451	0,020549
6,70	0,0200	843,5	1,326	0,0450	1,32678	52 59 40	0,979990	0,020010
6,80	0,0198	827,5	1,324	0,0448	1,32477	52 57 17	0,980199	0,019801
6,90	0,0197	820,92	1,323	0,0451	1,32375	52 55 53	0,980297	0,019703
7,00	0,0195	819,92	1,321	0,0457	1,32178	52 53 25	0,980492	0,019508
7,20	0,0187	806,61	1,313	0,0463	1,31381	52 43 25	0,981295	0,018705
7,40	0,0177	790,15	1,303	0,0466	1,30384	52 30 46	0,982288	0,017712

TABLE 1 (continued)

$\lambda \mu$	$\rho_{\lambda 0}$	$a_{\lambda} \frac{1}{\text{cm}}$	$n_{\lambda}$	$x_{\lambda}$	$  \dot{n}_{\lambda}  $	$\varphi_{\lambda}$	$\epsilon_{\lambda 0}$	$\rho_{\lambda 0}(\text{calc.})$
7,60	0,0172	799,82	1,298	0,0484	1,29890	52°24'28"	0,982748	0,017252
7,80	0,0168	760,0	1,294	0,0472	1,29487	52 19 18	0,983159	0,016841
8,00	0,0166	741,04	1,292	0,0472	1,28987	52 16 46	0,973352	0,016648
8,20	0,0164	729,5	1,289	0,0472	1,29288	52 12 53	0,983641	0,016359
8,40	0,0162	707,13	1,287	0,0473	1,28789	52 10 20	0,983831	0,016169
8,60	0,0157	695,07	1,282	0,0476	1,28288	52 03 49	0,984301	0,015699
8,80	0,0151	689,29	1,276	0,0483	1,27673	51 55 48	0,984851	0,015149
9,00	0,0144	694,94	1,268	0,0498	1,26858	51 45 07	0,985562	0,014438
9,20	0,0135	707,13	1,257	0,0518	1,25805	51 31 10	0,986514	0,013486
9,40	0,0127	724,2	1,247	0,0542	1,24818	51 17 58	0,987342	0,012658
9,60	0,0118	735,26	1,236	0,0562	1,23728	51 02 15	0,988236	0,011764
9,80	0,0109	762,52	1,224	0,0595	1,22543	50 47 33	0,989148	0,010852
10,0	0,0099	754,86	1,212	0,0601	1,21349	50 30 32	0,990084	0,009916
10,2	0,0092	764,65	1,202	0,0621	1,20360	50 16 44	0,990797	0,009203
10,4	0,0085	829,71	1,190	0,0687	1,19198	50 00 20	0,991497	0,008503
10,6	0,0078	950,29	1,175	0,0802	1,17774	49 39 56	0,992177	0,007823
10,8	0,0073	1100,1	1,159	0,0946	1,16286	49 18 22	0,992671	0,007329
10,9	0,0070	1144,2	1,150	0,0993	1,15428	49 05 42	0,993014	0,006989
11,0	0,0072	1299,9	1,143	0,1138	1,14865	48 57 32	0,992748	0,007252
11,1	0,0077	1459,5	1,137	0,1290	1,14431	48 51 00	0,992274	0,007726
11,2	0,0084	1649,1	1,129	0,1471	1,13898	48 43 04	0,991595	0,008405
11,3	0,0092	1819,1	1,121	0,1637	1,13290	48 33 55	0,990843	0,009157
11,4	0,0097	1929,2	1,114	0,1751	1,130308	48 30 02	0,990298	0,009702
11,5	0,0102	1999,6	1,111	0,1831	1,12685	48 24 47	0,989789	0,010211
11,6	0,0109	2036,0	1,118	0,1880	1,13371	48 35 08	0,989103	0,010897
11,7	0,0119	2079,3	1,130	0,1957	1,14648	48 54 14	0,988103	0,011897
11,8	0,0130	2119,1	1,144	0,1991	1,16115	49 15 52	0,986978	0,013022
12,0	0,0147	2154,0	1,165	0,2058	1,18303	49 47 22	0,985289	0,014711
12,5	0,0215	2449,3	1,219	0,2438	1,24318	51 11 14	0,978449	0,021551
13,0	0,0302	2819,7	1,270	0,2918	1,30308	52 29 50	0,969827	0,030173*
13,5	0,0355	2976,7	1,297	0,3202	1,33594	53 11 02	0,964539	0,035461
14,0	0,0410	3202,8	1,309	0,3582	1,35712	53 36 53	0,959012	0,040988
14,5	0,0472	3479,1	1,313	0,4028	1,37340	53 56 33	0,952793	0,047207
15,0	0,0512	3598,4	1,315	0,4088	1,38241	54 07 09	0,948781	0,051219

Note 1. The quantities  $\rho_{\lambda 0}$ ,  $n_{\lambda}$  and  $x_{\lambda}$  are presented for  $t = 20^{\circ}\text{C}$  ( $\lambda$  from 1 to 9  $\mu$ ) and  $18^{\circ}\text{C}$  ( $\lambda > 9\mu$ ).

Note 2.  $\rho_{\lambda 0}$ ,  $x_{\lambda}$  are experimental data;  $n_{\lambda}$ ,  $a_{\lambda}$ ,  $|\dot{n}_{\lambda}|$ ,  $\varphi_{B_{\lambda}}$ ,  $\epsilon_{\lambda 0}$  are calculated data.

TABLE 2.

$\varphi = 10^\circ$															
$\infty$	$\lambda$	radiation coefficient				$\lambda$	radiation coefficient				$\lambda$	radiation coefficient			
	$\mu$	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	$ \epsilon_{p\lambda} $	$\mu$	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	$ \epsilon_{p\lambda} $	$\mu$	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	$ \epsilon_{p\lambda} $
	1,00	0,98126	0,97943	0,98035	1,00187	4,20	0,97943	0,97745	0,97844	1,00203	8,60	0,98505	0,98354	0,98429	1,00154
	1,05	0,98136	0,97954	0,98045	1,00186	4,30	0,97952	0,97755	0,97854	1,00202	8,80	0,98558	0,98411	0,98484	1,00149
	1,10	0,98146	0,97965	0,98055	1,00185	4,40	0,97962	0,97765	0,97863	1,00201	9,00	0,98626	0,98485	0,98555	1,00143
	1,20	0,98157	0,97975	0,98066	1,00184	4,50	0,97970	0,97774	0,97872	1,00200	9,20	0,98717	0,98584	0,98651	1,00134
	1,30	0,98176	0,97997	0,98086	1,00182	4,60	0,97989	0,97794	0,97892	1,00199	9,40	0,98796	0,98671	0,98733	1,00127
	1,40	0,98026	0,97834	0,97930	1,00195	4,70	0,97998	0,97805	0,97902	1,00198	9,60	0,98882	0,98764	0,98823	1,00119
	1,50	0,98205	0,98029	0,98117	1,00180	4,80	0,98019	0,97827	0,97923	1,00196	9,80	0,98969	0,98859	0,98914	1,00111
	1,60	0,98225	0,98050	0,98137	1,00178	4,90	0,98040	0,97850	0,97945	1,00194	10,0	0,99058	0,98957	0,99008	1,00102
	1,70	0,98235	0,98061	0,98147	1,00177	5,00	0,98071	0,97884	0,97977	1,00192	10,2	0,99126	0,99032	0,99079	1,00095
	1,80	0,98264	0,98092	0,98178	1,00175	5,10	0,98112	0,97928	0,98020	1,00188	10,4	0,99193	0,99105	0,99149	1,00089
	1,90	0,98293	0,98124	0,98208	1,00172	5,20	0,98162	0,97982	0,98072	1,00184	10,6	0,99258	0,99176	0,99217	1,00083
	2,00	0,98341	0,98176	0,98258	1,00168	5,30	0,98231	0,98057	0,98144	1,00178	10,8	0,99305	0,99228	0,99267	1,00078
	2,20	0,98444	0,98288	0,98366	1,00159	5,40	0,98289	0,98120	0,98204	1,00173	10,9	0,99338	0,99264	0,99301	1,00075
	2,40	0,98600	0,98457	0,98529	1,00145	5,50	0,98354	0,98190	0,98272	1,00167	11,0	0,99313	0,99235	0,99274	1,00078
	2,50	0,98697	0,98563	0,98630	1,00136	5,60	0,98416	0,98257	0,98337	1,00161	11,1	0,99268	0,99185	0,99227	1,00084
	2,60	0,98808	0,98685	0,98747	1,00125	5,70	0,98507	0,98356	0,98431	1,00153	11,2	0,99204	0,99114	0,99159	1,00091
	2,70	0,99091	0,98994	0,99042	1,00098	5,80	0,98666	0,98529	0,98597	1,00139	11,3	0,99133	0,99034	0,99084	1,00100

TABLE 2. (continued)

6	2,74	0,99291	0,99214	0,99253	1,00078	5,85	0,98812	0,98688	0,98750	1,00126	11,4	0,99082	0,98976	0,99029	1,00106
	2,77	0,99146	0,99054	0,99100	1,00093	5,90	0,98572	0,98426	0,98499	1,00148	11,5	0,99033	0,98923	0,98978	1,00112
	2,80	0,98644	0,98506	0,98575	1,00141	6,00	0,98078	0,97889	0,97983	1,00193	11,6	0,98968	0,98850	0,98910	1,00119
	2,85	0,98088	0,97901	0,97995	1,00191	6,04	0,97934	0,97732	0,97833	1,00206	11,7	0,98873	0,98746	0,98809	1,00128
	2,90	0,97636	0,97413	0,97524	1,00229	6,10	0,97822	0,97612	0,97717	1,00215	11,8	0,98765	0,98629	0,98697	1,00139
	2,95	0,97260	0,97008	0,97134	1,00260	6,20	0,97650	0,97427	0,97539	1,00228	12,0	0,98604	0,98452	0,98529	1,00154
	3,00	0,96740	0,96454	0,96599	1,00300	6,30	0,97762	0,97548	0,97655	1,00219	12,5	0,97949	0,97739	0,97844	1,00215
	3,02	0,96661	0,96366	0,96513	1,00306	6,40	0,97877	0,97673	0,97775	1,00209	13,0	0,97120	0,96842	0,96981	1,00287
	3,07	0,95783	0,95428	0,95606	1,00371	6,50	0,97979	0,97783	0,97881	1,00200	13,5	0,96610	0,96293	0,96452	1,00330
	3,10	0,95883	0,95535	0,95709	1,00364	6,60	0,98039	0,97849	0,97944	1,00195	14,0	0,96078	0,95720	0,95899	1,00375
	3,16	0,96049	0,95712	0,95881	1,00352	6,70	0,98091	0,97905	0,97998	1,00190	14,5	0,95479	0,95075	0,95277	1,00426
	3,20	0,96169	0,95840	0,96005	1,00343	6,80	0,98111	0,97927	0,98019	1,00188	15,0	0,95092	0,94659	0,94876	1,00457
	3,30	0,96497	0,96191	0,96344	1,00318	6,90	0,98120	0,97937	0,98029	1,00188					
	3,40	0,96772	0,96486	0,96629	1,00297	7,00	0,98139	0,97957	0,98048	1,00186					
	3,50	0,97080	0,96816	0,96948	1,00273	7,20	0,98216	0,98040	0,98128	1,00179					
	3,60	0,97320	0,97073	0,97197	1,00254	7,40	0,98312	0,98144	0,98228	1,00171					
	3,70	0,97552	0,97323	0,97438	1,00235	7,60	0,98356	0,98192	0,98274	1,00167					
	3,80	0,97745	0,97531	0,97638	1,00219	7,80	0,98395	0,98235	0,98315	1,00164					
	3,90	0,97850	0,97645	0,97748	1,00210	8,00	0,98414	0,98255	0,98334	1,00162					
	4,03	0,97913	0,97712	0,97812	1,00205	8,20	0,98442	0,98285	0,98363	1,00159					
	4,10	0,97922	0,97723	0,97823	1,00204	8,40	0,98460	0,98305	0,98382	1,00158					

TABLE 3.

$\varphi = 20^\circ$														
$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			
	$\mu$	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	
1,00	0,98399	0,97636	0,98018	1,00782	3,90	0,98157	0,97301	0,97729	1,00880	7,40	0,98562	0,97862	0,98212	1,00715
1,05	0,98408	0,97648	0,98028	1,00778	4,03	0,98212	0,97377	0,97794	1,00858	7,60	0,98601	0,97916	0,98258	1,00699
1,10	0,98417	0,97660	0,98039	1,00775	4,10	0,98221	0,97389	0,97805	1,00854	7,80	0,98635	0,97964	0,98300	1,00685
1,20	0,98426	0,97673	0,98049	1,00771	4,20	0,98239	0,97413	0,97826	1,00847	8,00	0,98651	0,97987	0,98319	1,00678
1,30	0,98443	0,97697	0,98070	1,00764	4,30	0,98247	0,97425	0,97836	1,00844	8,20	0,98675	0,98021	0,98348	1,00667
1,40	0,98311	0,97514	0,97913	1,00818	4,40	0,98255	0,97436	0,97846	1,00840	8,40	0,98691	0,98044	0,98367	1,00661
1,50	0,98469	0,97733	0,98101	1,00753	4,50	0,98263	0,97447	0,97855	1,00838	8,60	0,98730	0,98099	0,98415	1,00644
1,60	0,98486	0,97757	0,98121	1,00746	4,60	0,98279	0,97469	0,97874	1,00831	8,80	0,98776	0,98164	0,98470	1,00624
1,70	0,98494	0,97768	0,98131	1,00742	4,70	0,98288	0,97481	0,97884	1,00828	9,00	0,98835	0,98248	0,98542	1,00598
1,80	0,98520	0,97804	0,98162	1,00732	4,80	0,98306	0,97506	0,97906	1,00820	9,20	0,98915	0,98361	0,98638	1,00563
1,90	0,98545	0,97840	0,98192	1,00721	4,90	0,98324	0,97531	0,97927	1,00813	9,40	0,98983	0,98459	0,98721	1,00532
2,00	0,98587	0,97898	0,98243	1,00703	5,00	0,98351	0,97569	0,97960	1,00802	9,60	0,99057	0,98565	0,98811	1,00499
2,20	0,98677	0,98026	0,98351	1,00665	5,10	0,98387	0,97619	0,98003	1,00787	9,80	0,99132	0,98674	0,98903	1,00464
2,40	0,98813	0,98217	0,98515	1,00606	5,20	0,98431	0,97680	0,98056	1,00769	10,00	0,99209	0,98786	0,98997	1,00429
2,50	0,98897	0,98337	0,98617	1,00569	5,30	0,98491	0,97764	0,98128	1,00744	10,20	0,99267	0,98871	0,99069	1,00400

TABLE 3 (continued)

2,60	0,98993	0,98475	0,98734	1,00526	5,40	0,98542	0,97835	0,98188	1,00723	10,4	0,99325	0,98955	0,99140	1,00374		
2,70	0,99237	0,98828	0,99032	1,00413	5,50	0,98599	0,97915	0,98257	1,00699	10,6	0,99381	0,99036	0,99208	1,00348		
2,74	0,99408	0,99081	0,99245	1,00330	5,60	0,98653	0,97991	0,98322	1,00676	10,8	0,99421	0,99095	0,99258	1,00330		
2,77	0,99284	0,98898	0,99091	1,00391	5,70	0,98732	0,98102	0,98417	1,00642	10,9	0,99450	0,99136	0,99293	1,00317		
2,80	0,98854	0,98271	0,98562	1,00591	5,80	0,98870	0,98298	0,98584	1,00583	11,0	0,99429	0,99102	0,99266	1,00330		
2,85	0,98367	0,97588	0,97978	1,00797	5,85	0,98997	0,98478	0,98738	1,00527	11,1	0,99392	0,99043	0,99217	1,00352		
2,90	0,97969	0,97040	0,97505	1,00957	5,90	0,98789	0,98180	0,98484	1,00621	11,2	0,99339	0,98958	0,99148	1,00385		
2,95	0,97636	0,96589	0,97112	1,01084	6,00	0,98360	0,97571	0,97966	1,00809	11,3	0,99280	0,98864	0,99072	1,00420		
3,00	0,97176	0,95975	0,96576	1,01251	6,04	0,98235	0,97394	0,97814	1,00863	11,4	0,99238	0,98796	0,99017	1,00447		
3,02	0,97102	0,95877	0,96490	1,01278	6,10	0,98135	0,97260	0,97697	1,00899	11,5	0,99198	0,98733	0,98965	1,00471		
3,07	0,96313	0,94845	0,95579	1,01547	6,20	0,97982	0,97056	0,97519	1,00955	11,6	0,99142	0,98650	0,98896	1,00499		
3,10	0,96404	0,94963	0,95683	1,01517	6,30	0,98080	0,97192	0,97636	1,00914	11,7	0,99060	0,98530	0,98795	1,00538		
3,16	0,96553	0,95157	0,95855	1,01467	6,40	0,98182	0,97332	0,97757	1,00873	11,8	0,98968	0,98395	0,98682	1,00582		
3,20	0,96661	0,95298	0,95980	1,01430	6,50	0,98270	0,97456	0,97863	1,00836	12,0	0,98828	0,98195	0,98511	1,00645		
3,30	0,96955	0,95684	0,96319	1,01328	6,60	0,98324	0,97530	0,97927	1,00814	12,5	0,98259	0,97385	0,97822	1,00898		
3,40	0,97201	0,96011	0,96606	1,01240	6,70	0,98369	0,97593	0,97981	1,00796	13,0	0,97532	0,96377	0,96954	1,01199		
3,50	0,97476	0,96377	0,96926	1,01140	6,80	0,98387	0,97617	0,98002	1,00788	13,5	0,97081	0,95765	0,96423	1,01374		
3,60	0,97689	0,96663	0,97176	1,01061	6,90	0,98395	0,97629	0,98012	1,00785	14,0	0,96608	0,95125	0,95867	1,01560		
3,70	0,97894	0,96941	0,97418	1,00983	7,00	0,98411	0,97651	0,98031	1,00778	14,5	0,96075	0,94406	0,95241	1,01768		
3,80	0,98065	0,97174	0,97620	1,00916	7,20	0,98479	0,97745	0,98112	1,00750	15,0	0,95729	0,93945	0,94837	1,01899		

TABLE 4.

$\varphi = 30^\circ$														
$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			
	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	
1,00	0,98853	0,97010	0,97923	1,01900	3,90	0,98667	0,96604	0,97634	1,02135	7,40	0,98977	0,97284	0,98130	1,01740
1,05	0,98860	0,97025	0,97942	1,01891	4,03	0,98709	0,96695	0,97702	1,02083	7,60	0,99006	0,97350	0,98178	1,01701
1,10	0,98866	0,97040	0,97953	1,01882	4,10	0,98716	0,96710	0,97713	1,02074	7,80	0,99033	0,97410	0,98221	1,01666
1,20	0,98873	0,97054	0,97964	1,01874	4,20	0,98730	0,96740	0,97734	1,02057	8,00	0,99045	0,97437	0,98241	1,01650
1,30	0,98886	0,97084	0,97985	1,01857	4,30	0,98736	0,96754	0,97745	1,02049	8,20	0,99063	0,97479	0,98271	1,01625
1,40	0,98786	0,96862	0,97824	1,01986	4,40	0,98743	0,96767	0,97755	1,02041	8,40	0,99075	0,97507	0,98291	1,01608
1,50	0,98906	0,97128	0,98017	1,01830	4,50	0,98748	0,96780	0,97764	1,02034	8,60	0,99104	0,97575	0,98339	1,01568
1,60	0,98919	0,97157	0,98038	1,01814	4,60	0,98761	0,96807	0,97784	1,02018	8,80	0,99139	0,97655	0,98397	1,01520
1,70	0,98925	0,97171	0,98048	1,01805	4,70	0,98767	0,96821	0,97794	1,02010	9,00	0,99183	0,97758	0,98470	1,01458
1,80	0,98945	0,97215	0,98080	1,01780	4,80	0,98781	0,96851	0,97816	1,01993	9,20	0,99242	0,97897	0,98570	1,01373
1,90	0,98964	0,97258	0,98111	1,01754	4,90	0,98795	0,96882	0,97839	1,01975	9,40	0,99293	0,98019	0,98656	1,01300
2,00	0,98996	0,97330	0,98163	1,01711	5,00	0,98816	0,96929	0,97873	1,01947	9,60	0,99347	0,98151	0,98749	1,01219
2,20	0,99064	0,97486	0,98275	1,01619	5,10	0,98844	0,96989	0,97917	1,01912	9,80	0,99402	0,98286	0,98844	1,01135
2,40	0,99165	0,97721	0,98443	1,01477	5,20	0,98877	0,97064	0,97970	1,01869	10,0	0,99458	0,98426	0,98942	1,01048
2,50	0,99228	0,97870	0,98549	1,01387	5,30	0,98923	0,97166	0,98044	1,01809	10,2	0,99500	0,98533	0,99017	1,00981

TABLE 4 (continued)

	2,60	0,99299	0,98041	0,98670	1,01283	5,40	0,98961	0,97252	0,98107	1,01758	10,4	0,99542	0,98639	0,99090	1,00916					
	2,70	0,99477	0,98482	0,98980	1,01010	5,50	0,99005	0,97350	0,98177	1,01700	10,6	0,99582	0,98740	0,99161	1,00853					
	2,74	0,99600	0,98801	0,99201	1,00809	5,60	0,99046	0,97443	0,98244	1,01645	10,8	0,99612	0,98812	0,99212	1,00810					
	2,77	0,99512	0,98568	0,99040	1,00957	5,70	0,99105	0,97579	0,98342	1,01564	10,9	0,99633	0,98864	0,99248	1,00778					
	2,80	0,99195	0,97787	0,98491	1,01440	5,80	0,99209	0,97819	0,98514	1,01420	11,0	0,99620	0,98819	0,99219	1,00811					
	2,85	0,98829	0,96950	0,97890	1,01937	5,85	0,99304	0,98042	0,98673	1,01286	11,1	0,99595	0,98740	0,99168	1,00866					
	2,90	0,98522	0,96288	0,97405	1,02319	5,90	0,99150	0,97671	0,98411	1,01513	11,2	0,99559	0,98628	0,99094	1,00945					
	2,95	0,98261	0,95748	0,97005	1,02624	6,00	0,98827	0,96923	0,97875	1,01964	11,3	0,99520	0,98503	0,99012	1,01032					
	3,00	0,97896	0,95021	0,96458	1,03026	6,04	0,98731	0,96706	0,97719	1,02094	11,4	0,99492	0,98412	0,98952	1,01097					
	3,02	0,97837	0,94905	0,96371	1,03089	6,10	0,98653	0,96547	0,97600	1,02181	11,5	0,99465	0,98329	0,98900	1,01155					
	3,07	0,97197	0,93698	0,95448	1,03734	6,20	0,98533	0,96304	0,97419	1,02314	11,6	0,99425	0,98224	0,98824	1,01222					
	3,10	0,97271	0,93835	0,95553	1,03662	6,30	0,98609	0,96469	0,97539	1,02218	11,7	0,99365	0,98073	0,98719	1,01317					
	3,16	0,97393	0,94062	0,95727	1,03542	6,40	0,98687	0,96640	0,97663	1,02118	11,8	0,99297	0,97906	0,98601	1,01421					
	3,20	0,97481	0,94226	0,95853	1,03454	6,50	0,98755	0,96790	0,97772	1,02030	12,0	0,99193	0,97657	0,98425	1,01573					
	3,30	0,97718	0,94680	0,96199	1,03209	6,60	0,98796	0,96880	0,97838	1,01978	12,5	0,98765	0,96659	0,97712	1,02178					
	3,40	0,97915	0,95064	0,96490	1,02999	6,70	0,98830	0,96956	0,97893	1,01933	13,0	0,98200	0,95438	0,96819	1,02894					
	3,50	0,98134	0,95498	0,96816	1,02760	6,80	0,98844	0,96986	0,97915	1,01916	13,5	0,97843	0,94707	0,96275	1,03311					
	3,60	0,98302	0,95839	0,97070	1,02570	6,90	0,98850	0,96999	0,97925	1,01907	14,0	0,97465	0,93942	0,95704	1,03750					
	3,70	0,98463	0,96171	0,97317	1,02382	7,00	0,98863	0,97028	0,97945	1,01891	14,5	0,97035	0,93087	0,95061	1,04241					
	3,80	0,98595	0,96451	0,97523	1,02223	7,20	0,98914	0,97142	0,98028	1,01824	15,0	0,96753	0,92543	0,94647	1,04550					

TABLE 5.

$\varphi = 40^\circ$														
$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\lambda$	Radiation coefficient			
	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	
1,00	0,99443	0,95820	0,97631	1,03781	3,90	0,99333	0,95291	0,97312	1,04241	7,40	0,99514	0,96178	0,97846	1,03469
1,05	0,99447	0,95839	0,97643	1,03764	4,03	0,99358	0,95409	0,97384	1,04139	7,60	0,99531	0,96265	0,97898	1,03393
1,10	0,99450	0,95859	0,97654	1,03747	4,10	0,99362	0,95429	0,97395	1,04122	7,80	0,99545	0,96343	0,97944	1,03324
1,20	0,99454	0,95878	0,97666	1,03730	4,20	0,99370	0,95467	0,97419	1,04088	8,00	0,99552	0,96380	0,97966	1,03291
1,30	0,99462	0,95916	0,97689	1,03697	4,30	0,99374	0,95485	0,97430	1,04073	8,20	0,99563	0,96436	0,97999	1,03242
1,40	0,99403	0,95626	0,97515	1,03950	4,40	0,99378	0,95503	0,97440	1,04058	8,40	0,99569	0,96472	0,98021	1,03210
1,50	0,99473	0,95974	0,97724	1,03646	4,50	0,99381	0,95519	0,97450	1,04043	8,60	0,99586	0,96563	0,98074	1,03130
1,60	0,99481	0,96012	0,97746	1,03613	4,60	0,99389	0,95554	0,97471	1,04013	8,80	0,99605	0,96669	0,98137	1,03037
1,70	0,99485	0,96031	0,97758	1,03596	4,70	0,99392	0,95573	0,97483	1,03997	9,00	0,99629	0,96807	0,98218	1,02914
1,80	0,99496	0,96089	0,97792	1,03546	4,80	0,99401	0,95612	0,97506	1,03962	9,20	0,99661	0,96994	0,98326	1,02749
1,90	0,99507	0,96146	0,97826	1,03496	4,90	0,99409	0,95652	0,97501	1,03927	9,40	0,99688	0,97158	0,98423	1,02604
2,00	0,99525	0,96240	0,97882	1,03413	5,00	0,99421	0,95713	0,97567	1,03874	9,60	0,99716	0,97337	0,98527	1,02445
2,20	0,99563	0,96447	0,98005	1,03231	5,10	0,99437	0,95792	0,97615	1,03805	9,80	0,99745	0,97521	0,98633	1,02281
2,40	0,99619	0,96761	0,98190	1,02953	5,20	0,99457	0,95890	0,97673	1,03720	10,0	0,99773	0,97713	0,98743	1,02109
2,50	0,99653	0,96961	0,98307	1,02777	5,30	0,99483	0,96024	0,97753	1,03603	10,2	0,99795	0,97860	0,98827	1,01976

TABLE 5 (continued)

2,60	0,99691	0,97192	0,98442	1,02572	5,40	0,99505	0,96138	0,97821	1,03503	10,4	0,99815	0,98005	0,98910	1,01847
2,70	0,99783	0,97794	0,98788	1,02033	5,50	0,99530	0,96267	0,97898	1,03389	10,6	0,99835	0,98144	0,98989	1,01723
2,74	0,99842	0,98237	0,99040	1,01634	5,60	0,99553	0,96389	0,97971	1,03282	10,8	0,99849	0,98241	0,99045	1,01637
2,77	0,99800	0,97912	0,98856	1,01928	5,70	0,99586	0,96569	0,98078	1,03124	10,9	0,99859	0,98311	0,99085	1,01574
2,80	0,99636	0,96846	0,98241	1,02880	5,80	0,99643	0,96890	0,98266	1,02812	11,0	0,99853	0,98241	0,99047	1,01641
2,85	0,99428	0,95738	0,97583	1,03854	5,85	0,99694	0,97188	0,98441	1,02578	11,1	0,99842	0,98124	0,98983	1,01751
2,90	0,99244	0,94880	0,97062	1,04600	5,90	0,99611	0,96687	0,98149	1,03024	11,2	0,99826	0,97956	0,98891	1,01910
2,95	0,99082	0,94190	0,96636	1,05194	6,00	0,99426	0,95689	0,97557	1,03906	11,3	0,99808	0,97770	0,98789	1,02085
3,00	0,98848	0,93274	0,96061	1,05976	6,04	0,99370	0,95403	0,97386	1,04158	11,4	0,99794	0,97632	0,98713	1,02214
3,02	0,98809	0,93129	0,95969	1,06099	6,10	0,99323	0,95201	0,97262	1,04329	11,5	0,99781	0,97510	0,98645	1,02329
3,07	0,98379	0,91641	0,95010	1,07353	6,20	0,99251	0,94895	0,97073	1,04590	11,6	0,99760	0,97364	0,98562	1,02461
3,10	0,98430	0,91808	0,95119	1,07213	6,30	0,99297	0,95111	0,97204	1,04402	11,7	0,99729	0,97158	0,98443	1,02646
3,16	0,98513	0,92086	0,95299	1,06980	6,40	0,99344	0,95333	0,97339	1,04207	11,8	0,99692	0,96931	0,98312	1,02848
3,20	0,98572	0,92289	0,95430	1,06809	6,50	0,99385	0,95529	0,97457	1,04036	12,0	0,99635	0,96599	0,98117	1,03143
3,30	0,98731	0,92851	0,95791	1,06332	6,60	0,99409	0,95647	0,97528	1,03933	12,5	0,99385	0,95271	0,97328	1,04318
3,40	0,98861	0,93332	0,96096	1,05924	6,70	0,99429	0,95747	0,97588	1,03846	13,0	0,99029	0,93690	0,96359	1,05698
3,50	0,99002	0,93877	0,96439	1,05460	6,80	0,99437	0,95786	0,97612	1,03812	13,5	0,98791	0,92763	0,95777	1,06498
3,60	0,99108	0,94309	0,96708	1,05089	6,90	0,99441	0,95804	0,97623	1,03796	14,0	0,98529	0,91795	0,95162	1,07336
3,70	0,99208	0,94733	0,96971	1,04724	7,00	0,99448	0,95840	0,97644	1,03633	14,5	0,98219	0,90721	0,94470	1,03265
3,80	0,99290	0,95093	0,97191	1,04413	7,20	0,99478	0,95991	0,97734	1,03633	15,0	0,98009	0,90043	0,94027	1,08848

TABLE 6.

$\varphi = 50^\circ$														
$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$
	$\mu$	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $		$\mu$	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $		$\mu$	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $
1,00	0,99953	0,93508	0,96731	1,06893	4,20	0,99937	0,93018	0,96477	1,07439	8,60	0,99976	0,94553	0,97264	1,05735
1,05	0,99954	0,93535	0,96745	1,06863	4,30	0,99938	0,93043	0,96490	1,07410	8,80	0,99978	0,94706	0,97342	1,05567
1,10	0,99955	0,93562	0,96758	1,06833	4,40	0,99939	0,93067	0,96503	1,07384	9,00	0,99981	0,94904	0,97443	1,05350
1,20	0,99956	0,93589	0,96772	1,06803	4,50	0,99939	0,93089	0,96514	1,07359	9,20	0,99985	0,95175	0,97580	1,05054
1,30	0,99957	0,93643	0,96800	1,06743	4,60	0,99941	0,93138	0,96540	1,07304	9,40	0,99987	0,95413	0,97700	1,04794
1,40	0,99945	0,93238	0,96591	1,07193	4,70	0,99942	0,93163	0,96552	1,07276	9,60	0,99990	0,95676	0,97833	1,04509
1,50	0,99959	0,93723	0,96842	1,06653	4,80	0,99943	0,93218	0,96581	1,07215	9,80	0,99991	0,95947	0,97969	1,04215
1,60	0,99961	0,93777	0,96869	1,06594	4,90	0,99945	0,93274	0,96610	1,07152	10,0	0,99993	0,96234	0,98113	1,03905
1,70	0,99962	0,93804	0,96883	1,06564	5,00	0,99948	0,93358	0,96653	1,07059	10,2	0,99993	0,96456	0,98224	1,03667
1,80	0,99964	0,93885	0,96924	1,06475	5,10	0,99952	0,93469	0,96710	1,06935	10,4	0,99992	0,96673	0,98332	1,03434
1,90	0,99966	0,93965	0,96966	1,06386	5,20	0,99956	0,93605	0,96780	1,06785	10,6	0,99990	0,96879	0,98434	1,03210
2,00	0,99969	0,94099	0,97034	1,06238	5,30	0,99961	0,93793	0,96877	1,06576	10,8	0,99984	0,97018	0,98501	1,03057
2,20	0,99976	0,94393	0,97184	1,05914	5,40	0,99965	0,93954	0,96959	1,06398	10,9	0,99982	0,97123	0,98552	1,02944
2,40	0,99984	0,94844	0,97414	1,05420	5,50	0,99970	0,94136	0,97053	1,06197	11,0	0,99975	0,97000	0,98488	1,03066
2,50	0,99988	0,95133	0,97561	1,05104	5,60	0,99973	0,94309	0,97141	1,06006	11,1	0,99965	0,96801	0,98383	1,03268
2,60	0,99992	0,95470	0,97731	1,04737	5,70	0,99977	0,94565	0,97271	1,05723	11,2	0,99950	0,96517	0,98234	1,03557
2,70	0,99998	0,96366	0,98182	1,03769	5,80	0,99983	0,95023	0,97503	1,05220	11,3	0,99932	0,96204	0,98068	1,03875

TABLE 6 (continued)

2,74	0,99999	0,97042	0,98520	1,03047	5,85	0,99986	0,95454	0,97720	1,04747	11,4	0,99916	0,95972	0,97944	1,04110
2,77	0,99997	0,96542	0,98270	1,03579	5,90	0,99972	0,94721	0,97347	1,05544	11,5	0,99904	0,95770	0,97837	1,04316
2,80	0,99982	0,94961	0,97472	1,05288	6,00	0,99925	0,93293	0,96609	1,07108	11,6	0,99899	0,95552	0,97725	1,04550
2,85	0,99945	0,93387	0,96666	1,07022	6,04	0,99905	0,92890	0,96398	1,07551	11,7	0,99894	0,95250	0,97572	1,04876
2,90	0,99899	0,92206	0,96053	1,08343	6,10	0,99902	0,92624	0,96263	1,07857	11,8	0,99888	0,94922	0,97405	1,05232
2,95	0,99851	0,91278	0,95564	1,09393	6,20	0,99893	0,92219	0,96056	1,08321	12,0	0,99880	0,94449	0,97164	1,05750
3,00	0,99772	0,90069	0,94521	1,10773	6,30	0,99910	0,92518	0,96214	1,07990	12,5	0,99801	0,92573	0,96187	1,07807
3,02	0,99758	0,89880	0,94819	1,10990	6,40	0,99925	0,92827	0,96376	1,07647	13,0	0,99650	0,90425	0,95038	1,10203
3,07	0,99587	0,87971	0,93779	1,13204	6,50	0,99936	0,93099	0,96517	1,07344	13,5	0,99536	0,89203	0,94369	1,11584
3,10	0,99609	0,88183	0,93896	1,12957	6,60	0,99943	0,93263	0,96603	1,07162	14,0	0,99377	0,87931	0,93654	1,13017
3,16	0,99644	0,88537	0,94090	1,12545	6,70	0,99947	0,93403	0,96675	1,07007	14,5	0,99162	0,86535	0,92849	1,14591
3,20	0,99669	0,88796	0,94232	1,12244	6,80	0,99949	0,93457	0,96703	1,06947	15,0	0,99012	0,85670	0,92341	1,15574
3,30	0,99734	0,89524	0,94629	1,11405	6,90	0,99950	0,93482	0,96716	1,06918					
3,40	0,99783	0,90150	0,94966	1,10685	7,00	0,99951	0,93533	0,96742	1,06862					
3,50	0,99832	0,90868	0,95350	1,09864	7,20	0,99957	0,93743	0,96850	1,06629					
3,60	0,99866	0,91443	0,95654	1,09210	7,40	0,99964	0,94006	0,96985	1,06338					
3,70	0,99895	0,92015	0,95955	1,08564	7,60	0,99967	0,94129	0,97048	1,06202					
3,80	0,99917	0,92504	0,96211	1,08013	7,80	0,99969	0,94240	0,97105	1,06079					
3,90	0,99928	0,92776	0,96352	1,07709	8,00	0,99970	0,94293	0,97132	1,06021					
4,03	0,99934	0,92938	0,96436	1,07527	8,20	0,99972	0,94372	0,97172	1,05934					
4,10	0,99935	0,92965	0,96450	1,07498	8,40	0,99973	0,94424	0,97198	1,05877					

TABLE 7.

$\varphi = 60^\circ$														
$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{p\lambda} }$	$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$
	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	
1,00	0,99560	0,88767	0,94163	1,12159	3,90	0,99596	0,87716	0,93656	1,13544	7,40	0,99519	0,89486	0,94503	1,11212
1,05	0,99558	0,88806	0,94182	1,12108	4,03	0,99588	0,87947	0,93767	1,13236	7,60	0,99513	0,89666	0,94590	1,10981
1,10	0,99557	0,88845	0,94201	1,12057	4,10	0,99586	0,87985	0,93786	1,13185	7,80	0,99509	0,89833	0,94671	1,10771
1,20	0,99556	0,88884	0,94220	1,12006	4,20	0,99583	0,88060	0,93822	1,13085	8,00	0,99507	0,89911	0,94709	1,10673
1,30	0,99553	0,88962	0,94258	1,11905	4,30	0,99582	0,88096	0,93839	1,13037	8,20	0,99504	0,90028	0,94766	1,10525
1,40	0,99573	0,88376	0,93975	1,12669	4,40	0,99580	0,88130	0,93855	1,12992	8,40	0,99502	0,90106	0,94804	1,10428
1,50	0,99550	0,89080	0,94315	1,11753	4,50	0,99578	0,88162	0,93870	1,12949	8,60	0,99497	0,90299	0,94898	1,10185
1,60	0,99547	0,89159	0,94353	1,11651	4,60	0,99575	0,88231	0,93903	1,12857	8,80	0,99491	0,90529	0,95010	1,09899
1,70	0,99546	0,89198	0,94372	1,11601	4,70	0,99573	0,88268	0,93902	1,12808	9,00	0,99483	0,90829	0,95156	1,09527
1,80	0,99542	0,89316	0,94429	1,11449	4,80	0,99571	0,88346	0,93958	1,12705	9,20	0,99473	0,91242	0,95357	1,09021
1,90	0,99539	0,89435	0,94487	1,11298	4,90	0,99568	0,88427	0,93998	1,12599	9,40	0,99465	0,91609	0,95537	1,08576
2,00	0,99533	0,89632	0,94583	1,11046	5,00	0,99564	0,88549	0,94057	1,12440	9,60	0,99458	0,92017	0,95737	1,08087
2,20	0,99522	0,90069	0,94796	1,10495	5,10	0,99560	0,88709	0,94134	1,12231	9,80	0,99451	0,92443	0,95947	1,07580
2,40	0,99506	0,90749	0,95128	1,09651	5,20	0,99553	0,88907	0,94230	1,11975	10,0	0,99448	0,92901	0,96175	1,07047
2,50	0,99498	0,91190	0,95344	1,09111	5,30	0,99545	0,89181	0,94363	1,11620	10,2	0,99446	0,93258	0,96352	1,06636

TABLE 7 (continued)

2,60	0,99491	0,91713	0,95602	1,08481	5,40	0,99538	0,89417	0,94477	1,11319	10,4	0,99439	0,93606	0,96522	1,06231						
2,70	0,99482	0,93135	0,96309	1,06814	5,50	0,99529	0,89686	0,94607	1,10976	10,6	0,99421	0,93932	0,96676	1,05843						
2,74	0,99490	0,94250	0,96870	1,05560	5,60	0,99520	0,89942	0,94731	1,10649	10,8	0,99390	0,94138	0,96764	1,05578						
2,77	0,99473	0,93416	0,96445	1,06484	5,70	0,99506	0,90322	0,94914	1,10167	10,9	0,99378	0,94302	0,96840	1,05382						
2,80	0,99482	0,90915	0,95199	1,09422	5,80	0,99478	0,91009	0,95243	1,09305	11,0	0,99326	0,94063	0,96694	1,05596						
2,85	0,99539	0,88580	0,94059	1,12372	5,85	0,99451	0,91665	0,95558	1,08495	11,1	0,99260	0,93688	0,96474	1,05947						
2,90	0,99598	0,86903	0,93250	1,14608	5,90	0,99453	0,90532	0,94993	1,09853	11,2	0,99163	0,93159	0,96161	1,06445						
2,95	0,99650	0,85622	0,92636	1,16383	6,00	0,99444	0,88399	0,93922	1,12495	11,3	0,99055	0,92585	0,95820	1,06988						
3,00	0,99721	0,83999	0,91860	1,18717	6,04	0,99433	0,87810	0,93622	1,13237	11,4	0,98965	0,92158	0,95561	1,07386						
3,02	0,99732	0,83750	0,91741	1,19083	6,10	0,99487	0,87450	0,93469	1,13764	11,5	0,98902	0,91802	0,95352	1,07734						
3,07	0,99837	0,81281	0,90559	1,22829	6,20	0,99561	0,86906	0,93233	1,14562	11,6	0,98892	0,91461	0,95177	1,08125						
3,10	0,99826	0,81550	0,90688	1,22411	6,30	0,99566	0,87332	0,93449	1,14008	11,7	0,98895	0,91005	0,94950	1,08671						
3,16	0,99809	0,82003	0,90906	1,21714	6,40	0,99564	0,87775	0,93670	1,13430	11,8	0,98908	0,90520	0,94714	1,09267						
3,20	0,99799	0,82338	0,91068	1,21206	6,50	0,99558	0,88167	0,93863	1,12921	12,0	0,98936	0,89832	0,94384	1,10134						
3,30	0,99772	0,83288	0,91530	1,19792	6,60	0,99555	0,88405	0,93980	1,12612	12,5	0,98922	0,87121	0,93021	1,13546						
3,40	0,99742	0,84115	0,91928	1,18578	6,70	0,99549	0,88606	0,94078	1,12349	13,0	0,98885	0,84168	0,91526	1,17486						
3,50	0,99703	0,85077	0,92390	1,17190	6,80	0,99546	0,88685	0,94116	1,12247	13,5	0,98856	0,82553	0,90705	1,19749						
3,60	0,99670	0,85859	0,92765	1,16085	6,90	0,99545	0,88721	0,94133	1,12199	14,0	0,98725	0,80885	0,89805	1,22057						
3,70	0,99638	0,86648	0,93143	1,14991	7,00	0,99542	0,88794	0,94168	1,12104	14,5	0,98511	0,79087	0,88799	1,24560						
3,80	0,99611	0,87332	0,93471	1,14059	7,20	0,99531	0,89100	0,94316	1,11708	15,0	0,98365	0,77996	0,88181	1,26115						

TABLE 8.

$\varphi = 70^\circ$														
$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$
	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	
1,00	0,95272	0,78417	0,86844	1,21494	3,90	0,95284	0,76956	0,86120	1,23816	7,40	0,95228	0,79429	0,87329	1,19890
1,05	0,95272	0,78472	0,86872	1,21409	4,03	0,95278	0,77274	0,86276	1,23300	7,60	0,95228	0,79688	0,87458	1,19502
1,10	0,95272	0,78527	0,86900	1,21324	4,10	0,95277	0,77326	0,86302	1,23215	7,80	0,95237	0,79929	0,87583	1,19150
1,20	0,95273	0,78583	0,86928	1,21239	4,20	0,95275	0,77430	0,86353	1,23047	8,00	0,95239	0,80043	0,87641	1,18984
1,30	0,95273	0,78694	0,86984	1,21068	4,30	0,95274	0,77479	0,86376	1,22967	8,20	0,95244	0,80215	0,87729	1,18736
1,40	0,95273	0,77869	0,86571	1,22350	4,40	0,95272	0,77526	0,86399	1,22890	8,40	0,95247	0,80328	0,87788	1,18572
1,50	0,95275	0,78861	0,87068	1,20813	4,50	0,95269	0,77570	0,86420	1,22818	8,60	0,95256	0,80613	0,87934	1,18164
1,60	0,95276	0,78973	0,87125	1,20643	4,60	0,95266	0,77665	0,86466	1,22662	8,80	0,95267	0,80952	0,88109	1,17683
1,70	0,95277	0,79030	0,87153	1,20558	4,70	0,95265	0,77716	0,86490	1,22581	9,00	0,95282	0,81400	0,88341	1,17055
1,80	0,95279	0,79199	0,87239	1,20303	4,80	0,95264	0,77825	0,86545	1,22408	9,20	0,95310	0,82022	0,88666	1,16200
1,90	0,95282	0,79369	0,87325	1,20049	4,90	0,95264	0,77938	0,86601	1,22230	9,40	0,95337	0,82582	0,88960	1,15446
2,00	0,95287	0,79654	0,87471	1,19627	5,00	0,95265	0,78109	0,86687	1,21964	9,60	0,95377	0,83214	0,89295	1,14616
2,20	0,95305	0,80291	0,87898	1,18699	5,10	0,95266	0,78335	0,86801	1,21615	9,80	0,95420	0,83882	0,89651	1,13755
2,40	0,95346	0,81299	0,88322	1,17279	5,20	0,95268	0,78614	0,86941	1,21184	10,0	0,95489	0,84617	0,90053	1,12144
2,50	0,95383	0,81967	0,88675	1,16367	5,30	0,95271	0,79004	0,87138	1,20590	10,2	0,95542	0,85196	0,90369	1,12144

TABLE 8 (continued)

2,60	0,95437	0,82771	0,89104	1,15303	5,40	0,95276	0,79342	0,87309	1,20083	10,4	0,95576	0,85759	0,90667	1,11448
2,70	0,95644	0,85042	0,90343	1,12467	5,50	0,95281	0,79729	0,87505	1,19506	10,6	0,95571	0,86275	0,90923	1,10775
2,74	0,95881	0,86919	0,91400	1,10311	5,60	0,95285	0,80101	0,87693	1,18956	10,8	0,95491	0,86568	0,91029	1,10307
2,77	0,95666	0,85494	0,90580	1,11898	5,70	0,95287	0,80655	0,87971	1,18142	10,9	0,95473	0,86821	0,91147	1,09965
2,80	0,95291	0,81530	0,88411	1,16878	5,80	0,95291	0,81669	0,88480	1,16680	11,0	0,95240	0,86333	0,90787	1,10317
2,85	0,95192	0,78135	0,86664	1,21830	5,85	0,95301	0,82655	0,88978	1,15300	11,1	0,94940	0,85614	0,90277	1,10894
2,90	0,95229	0,75837	0,85533	1,25572	5,90	0,95150	0,80924	0,88037	1,17579	11,2	0,94521	0,84618	0,89569	1,11703
2,95	0,95309	0,74146	0,84728	1,28542	6,00	0,94895	0,77814	0,86355	1,21952	11,3	0,94075	0,83570	0,88822	1,12571
3,00	0,95468	0,72074	0,83771	1,32457	6,04	0,94816	0,76984	0,85900	1,23163	11,4	0,93725	0,82798	0,88262	1,13197
3,02	0,95496	0,71762	0,83629	1,33072	6,10	0,94946	0,76521	0,85734	1,24078	11,5	0,93483	0,82186	0,87834	1,13745
3,07	0,95833	0,68754	0,82293	1,39386	6,20	0,95123	0,75820	0,85472	1,25460	11,6	0,93431	0,81681	0,87556	1,14384
3,10	0,95793	0,69075	0,82434	1,38680	6,30	0,95167	0,76407	0,85787	1,24553	11,7	0,93415	0,81032	0,87223	1,15282
3,16	0,95731	0,69620	0,82675	1,37505	6,40	0,95195	0,77019	0,86107	1,23599	11,8	0,93425	0,80356	0,86890	1,16265
3,20	0,95693	0,70027	0,82860	1,36652	6,50	0,95212	0,77564	0,86388	1,22753	12,0	0,93469	0,79412	0,86411	1,17700
3,30	0,95608	0,71197	0,83402	1,34287	6,60	0,95223	0,77898	0,86561	1,22240	12,5	0,93298	0,75702	0,84500	1,23243
3,40	0,95527	0,72232	0,83879	1,32252	6,70	0,95224	0,78180	0,86702	1,21800	13,0	0,93170	0,71896	0,82533	1,29589
3,50	0,95439	0,73456	0,84448	1,29926	6,80	0,95224	0,78291	0,86757	1,21629	13,5	0,93141	0,69911	0,81526	1,33228
3,60	0,95378	0,74471	0,84924	1,28074	6,90	0,95223	0,78342	0,86783	1,21548	14,0	0,92896	0,67886	0,80391	1,36841
3,70	0,95328	0,75513	0,85420	1,26240	7,00	0,95222	0,78444	0,86833	1,21388	14,5	0,92513	0,65757	0,79135	1,40688
3,80	0,95296	0,76433	0,85865	1,24679	7,20	0,95222	0,78877	0,87049	1,20723	15,0	0,92280	0,64498	0,78389	1,43073

TABLE 9.

$\varphi = 80^\circ$														
$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			
	$\epsilon_{p\lambda}$	$\epsilon_{s\lambda}$	$\epsilon_\lambda$			$\epsilon_{p\lambda}$	$\epsilon_{s\lambda}$	$\epsilon_\lambda$			$\epsilon_{p\lambda}$	$\epsilon_{s\lambda}$	$\epsilon_\lambda$	
1,00	0,76161	0,54727	0,65444	1,39164	3,90	0,76026	0,53117	0,64571	1,43129	7,40	0,76186	0,55864	0,66025	1,36377
1,05	0,76167	0,54789	0,65478	1,39019	4,03	0,76048	0,53462	0,64755	1,42248	7,60	0,76216	0,56162	0,66189	1,35709
1,10	0,76174	0,54851	0,65513	1,38873	4,10	0,76052	0,53519	0,64785	1,42103	7,80	0,76261	0,56442	0,66352	1,35114
1,20	0,76181	0,54914	0,65547	1,38727	4,20	0,76059	0,53633	0,64846	1,41815	8,00	0,76280	0,56575	0,66428	1,34829
1,30	0,76194	0,55039	0,65617	1,38437	4,30	0,76061	0,53686	0,64874	1,41678	8,20	0,76310	0,56776	0,66543	1,34406
1,40	0,76102	0,54117	0,65109	1,40625	4,40	0,76063	0,53738	0,64900	1,41544	8,40	0,76330	0,56909	0,66619	1,34126
1,50	0,76216	0,55229	0,65722	1,38000	4,50	0,76062	0,53785	0,64924	1,41419	8,60	0,76381	0,57244	0,66813	1,33431
1,60	0,76231	0,55356	0,65794	1,37711	4,60	0,76066	0,53890	0,64978	1,41150	8,80	0,76444	0,57648	0,67046	1,32605
1,70	0,76239	0,55420	0,65830	1,37566	4,70	0,76069	0,53945	0,65007	1,41011	9,00	0,76531	0,58185	0,67358	1,31531
1,80	0,76263	0,55613	0,65938	1,37132	4,80	0,76079	0,54066	0,65073	1,40716	9,20	0,76664	0,58943	0,67804	1,30066
1,90	0,76288	0,55808	0,66048	1,36698	4,90	0,76092	0,54191	0,65142	1,40414	9,40	0,76792	0,59636	0,68214	1,28769
2,00	0,76333	0,56137	0,66235	1,35976	5,00	0,76113	0,54382	0,65248	1,39959	9,60	0,76956	0,60431	0,68693	1,27344
2,20	0,76445	0,56880	0,66662	1,34396	5,10	0,76140	0,54634	0,65387	1,39364	9,80	0,77135	0,61287	0,69211	1,25858
2,40	0,76654	0,58084	0,67369	1,31971	5,20	0,76174	0,54948	0,65561	1,38631	10,0	0,77380	0,62253	0,69817	1,24298
2,50	0,76816	0,58901	0,67858	1,30415	5,30	0,76225	0,55390	0,65808	1,37615	10,2	0,77574	0,63027	0,70301	1,23080

TABLE 9 (continued)

2,60	0,77034	0,59904	0,68469	1,28595	5,40	0,76274	0,55776	0,66025	1,36750	10,4	0,77719	0,63780	0,70749	1,21855	
2,70	0,77797	0,62878	0,70338	1,23726	5,50	0,76330	0,56222	0,66276	1,35765	10,6	0,77758	0,64454	0,71106	1,20641	
2,74	0,78612	0,65515	0,72064	1,19991	5,60	0,76381	0,56654	0,66518	1,34821	10,8	0,77580	0,64785	0,71183	1,19751	
2,77	0,77905	0,63481	0,70693	1,22721	5,70	0,76452	0,57303	0,66877	1,33416	10,9	0,77552	0,65101	0,71327	1,19124	
2,80	0,76565	0,58344	0,67455	1,31230	5,80	0,76582	0,58511	0,67546	1,30885	11,0	0,76931	0,64310	0,70620	1,19626	
2,85	0,75970	0,54396	0,65183	1,39663	5,85	0,76722	0,59712	0,68217	1,28487	11,0	0,76151	0,63203	0,69677	1,20486	
2,90	0,75807	0,51904	0,63856	1,46051	5,90	0,76195	0,57580	0,66887	1,32330	11,2	0,75110	0,61731	0,68420	1,21673	
2,95	0,75803	0,50152	0,62977	1,51148	6,00	0,75349	0,53976	0,64663	1,39598	11,3	0,74061	0,60246	0,67154	1,22930	
3,00	0,75933	0,48085	0,62009	1,57913	6,04	0,75115	0,53056	0,64086	1,41576	11,4	0,73273	0,59183	0,66228	1,23807	
3,02	0,75962	0,47781	0,61872	1,58979	6,10	0,75325	0,52584	0,63955	1,43246	11,5	0,72743	0,58380	0,65562	1,24603	
3,07	0,76397	0,44934	0,60666	1,70019	6,20	0,75601	0,51868	0,63734	1,45755	11,6	0,72633	0,57803	0,65218	1,25657	
3,10	0,76340	0,45231	0,60785	1,68777	6,30	0,75741	0,52502	0,64122	1,44265	11,7	0,72592	0,57086	0,64839	1,27164	
3,16	0,76256	0,45739	0,60998	1,66720	6,40	0,75858	0,53168	0,64513	1,42675	11,8	0,72599	0,56353	0,64476	1,28830	
3,20	0,76211	0,46122	0,61167	1,65236	6,50	0,75948	0,53767	0,64858	1,41254	12,0	0,72654	0,55345	0,63999	1,31274	
3,30	0,76129	0,47240	0,61685	1,61155	6,60	0,76006	0,54139	0,65072	1,40390	12,5	0,72160	0,51402	0,61781	1,40384	
3,40	0,76056	0,48248	0,62152	1,57637	6,70	0,76038	0,54452	0,65245	1,39642	13,0	0,71777	0,47619	0,59698	1,50732	
3,50	0,75989	0,49465	0,62727	1,53621	6,80	0,76050	0,54576	0,65313	1,39349	13,5	0,71670	0,45744	0,58707	1,56675	
3,60	0,75962	0,50496	0,63229	1,50433	6,90	0,76055	0,54633	0,65344	1,39211	14,0	0,71223	0,43872	0,57547	1,62342	
3,70	0,75965	0,51577	0,63771	1,47284	7,00	0,76063	0,54747	0,65405	1,38936	14,5	0,70590	0,41962	0,56276	1,68223	
3,80	0,75996	0,52553	0,64275	1,44607	7,20	0,76112	0,55234	0,65673	1,37799	15,0	0,70229	0,40864	0,55546	1,71862	

TABLE 10.

$\varphi = 82^\circ$														
$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			
	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	
1,00	0,68013	0,47091	0,57552	1,44429	3,90	0,67851	0,45578	0,56715	1,48869	7,4	0,68054	0,48165	0,58109	1,41295
1,05	0,68021	0,47150	0,57585	1,44266	4,03	0,67879	0,45901	0,56890	1,47881	7,6	0,68090	0,48446	0,58268	1,40547
1,10	0,68029	0,47208	0,57618	1,44103	4,10	0,67884	0,45955	0,56919	1,47718	7,8	0,68141	0,48714	0,58427	1,39881
1,20	0,68036	0,47267	0,57652	1,43940	4,20	0,67893	0,46062	0,56977	1,47395	8,0	0,68163	0,48840	0,58501	1,39564
1,30	0,68053	0,47386	0,57719	1,43614	4,30	0,67896	0,46112	0,57004	1,47241	8,2	0,68196	0,49031	0,58613	1,39090
1,40	0,67944	0,46517	0,57230	1,46063	4,40	0,67898	0,46160	0,57029	1,47092	8,4	0,68219	0,49157	0,58688	1,38777
1,50	0,68078	0,47565	0,57821	1,43127	4,50	0,67898	0,46205	0,57051	1,46950	8,6	0,68277	0,49477	0,58887	1,37998
1,60	0,68096	0,47685	0,57890	1,42802	4,60	0,67903	0,46303	0,57103	1,46649	8,8	0,68349	0,49862	0,59106	1,37076
1,70	0,68104	0,47746	0,57925	1,42640	4,70	0,67907	0,46355	0,57131	1,46493	9,0	0,68448	0,50376	0,59412	1,35872
1,80	0,68132	0,47929	0,58030	1,42154	4,80	0,67920	0,46468	0,57194	1,46163	9,2	0,68598	0,51104	0,59851	1,34233
1,90	0,68161	0,48113	0,58137	1,41669	4,90	0,67935	0,46587	0,57261	1,45825	9,4	0,68743	0,51771	0,60257	1,32782
2,00	0,68213	0,48425	0,58319	1,40862	5,00	0,67959	0,46766	0,57362	1,45318	9,6	0,68926	0,52541	0,60733	1,31187
2,20	0,68340	0,49132	0,58736	1,39094	5,10	0,67991	0,47003	0,57497	1,44651	9,8	0,69128	0,53372	0,61250	1,29522
2,40	0,68577	0,50283	0,59430	1,36383	5,20	0,68031	0,47299	0,57665	1,43830	10,0	0,69401	0,54315	0,61858	1,27776
2,50	0,68759	0,51067	0,59913	1,34645	5,30	0,68090	0,47717	0,57904	1,42694	10,2	0,69619	0,55073	0,62346	1,26411

TABLE 10 (continued)

2,60	0,69005	0,52035	0,60520	1,32611	5,40	0,68145	0,48082	0,58114	1,41726	10,4	0,69782	0,55811	0,62796	1,25032
2,70	0,69859	0,54935	0,62397	1,27167	5,50	0,68211	0,48506	0,58358	1,40623	10,6	0,69829	0,56470	0,63149	1,23656
2,74	0,70773	0,57546	0,64160	1,22985	5,60	0,68270	0,48916	0,58593	1,39566	10,8	0,69636	0,56786	0,63211	1,22628
2,77	0,69982	0,55526	0,62754	1,26034	5,70	0,68353	0,49534	0,58943	1,37922	10,9	0,69605	0,57094	0,63349	1,21914
2,80	0,68486	0,50529	0,59507	1,35538	5,80	0,68505	0,50689	0,59597	1,35150	11,0	0,68924	0,56294	0,62609	1,22436
2,85	0,67809	0,46777	0,57293	1,44963	5,85	0,68668	0,51843	0,60256	1,32455	11,1	0,68074	0,55188	0,61631	1,23351
2,90	0,67607	0,44444	0,56026	1,52118	5,90	0,68084	0,49792	0,58938	1,36735	11,2	0,66952	0,53729	0,60340	1,24612
2,95	0,67583	0,42818	0,55201	1,57836	6,00	0,67152	0,46374	0,56763	1,44806	11,3	0,65832	0,52272	0,59052	1,25942
3,00	0,67694	0,40917	0,54306	1,65443	6,04	0,66898	0,45510	0,56204	1,46996	11,4	0,64998	0,51235	0,58117	1,26863
3,02	0,67721	0,40639	0,54180	1,66643	6,10	0,67112	0,45072	0,56092	1,48899	11,5	0,64442	0,50460	0,57451	1,27711
3,07	0,68144	0,38048	0,53096	1,79101	6,20	0,67391	0,44408	0,55900	1,51754	11,6	0,64328	0,49913	0,57120	1,28881
3,10	0,68087	0,38317	0,53202	1,77697	6,30	0,67546	0,45000	0,56273	1,50102	11,7	0,64286	0,49237	0,56762	1,30564
3,16	0,68006	0,38776	0,53392	1,75375	6,40	0,67676	0,45624	0,56650	1,48334	11,8	0,64293	0,48550	0,56422	1,32427
3,20	0,67962	0,39125	0,53544	1,73704	6,50	0,67778	0,46186	0,56982	1,46749	12,0	0,64349	0,47608	0,55978	1,35164
3,30	0,67889	0,40144	0,54017	1,69113	6,60	0,67843	0,46536	0,57189	1,45786	12,5	0,63822	0,43931	0,53876	1,45276
3,40	0,67824	0,41067	0,54445	1,65156	6,70	0,67881	0,46831	0,57356	1,44949	13,0	0,63409	0,40454	0,51932	1,56744
3,50	0,67769	0,42186	0,54977	1,60641	6,80	0,67896	0,46947	0,57421	1,44621	13,5	0,63292	0,38750	0,51021	1,63335
3,60	0,67753	0,43138	0,55446	1,57059	6,90	0,67901	0,47001	0,57451	1,44467	14,0	0,62831	0,37057	0,49944	1,69555
3,70	0,67769	0,44142	0,55955	1,53525	7,00	0,67911	0,47109	0,57510	1,44158	14,5	0,62188	0,35340	0,48764	1,75972
3,80	0,67813	0,45051	0,56432	1,50525	7,20	0,67968	0,47568	0,57768	1,42887	15,0	0,61824	0,34358	0,48091	1,79940

TABLE II.

$\varphi = 84^\circ$														
$\lambda$ $\mu$	Radiation coefficient			$ \epsilon_{p\lambda} $	$\lambda$ $\mu$	Radiation coefficient			$ \epsilon_{p\lambda} $	$\lambda$ $\mu$	Radiation coefficient			$ \epsilon_{p\lambda} $
	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	
1,0	0,57293	0,38060	0,47677	1,50535	3,90	0,57119	0,36727	0,46923	1,55522	7,40	0,57345	0,39010	0,48178	1,47000
1,05	0,57302	0,38112	0,47707	1,50352	4,03	0,57149	0,37011	0,47080	1,54411	7,60	0,57383	0,39261	0,48322	1,46159
1,10	0,57310	0,38164	0,47737	1,50169	4,10	0,57154	0,37058	0,47106	1,54229	7,80	0,57436	0,39499	0,48467	1,45413
1,20	0,57318	0,38216	0,47767	1,59986	4,20	0,57164	0,37152	0,47158	1,53866	8,00	0,57459	0,39611	0,48535	1,45058
1,30	0,57335	0,38320	0,47828	1,49621	4,30	0,57168	0,37196	0,47182	1,53692	8,20	0,57494	0,39781	0,48638	1,44526
1,40	0,57219	0,37553	0,47386	1,52370	4,40	0,57170	0,37239	0,47204	1,53524	8,40	0,57518	0,39894	0,48706	1,44175
1,50	0,57362	0,38479	0,47921	1,49074	4,50	0,57171	0,37278	0,47224	1,53364	8,60	0,57579	0,40180	0,48880	1,43301
1,60	0,57381	0,38586	0,47983	1,48710	4,60	0,57177	0,37364	0,47270	1,53025	8,80	0,57654	0,40525	0,49089	1,42267
1,70	0,57390	0,38640	0,48015	1,48528	4,70	0,57181	0,37410	0,47296	1,52850	9,00	0,57757	0,40986	0,49372	1,40917
1,80	0,57420	0,38802	0,48111	1,47983	4,80	0,57195	0,37510	0,47352	1,52479	9,20	0,57914	0,41641	0,49776	1,39078
1,90	0,57450	0,38966	0,48208	1,47438	4,90	0,57211	0,37614	0,47413	1,52100	9,40	0,58064	0,42244	0,50154	1,37449
2,00	0,57504	0,39243	0,48374	1,46543	5,00	0,57236	0,37772	0,47504	1,51531	9,60	0,58255	0,42942	0,50598	1,35660
2,20	0,57638	0,39874	0,48756	1,44551	5,10	0,57270	0,37982	0,47626	1,50783	9,80	0,58464	0,43698	0,51081	1,33790
2,40	0,57885	0,40904	0,49394	1,41513	5,20	0,57313	0,38244	0,47778	1,49862	10,0	0,58747	0,44561	0,51654	1,31833
2,50	0,58074	0,41611	0,49842	1,39565	5,30	0,57376	0,38614	0,47995	1,48587	10,2	0,58972	0,45259	0,52115	1,30301

TABLE 11 (continued)

2,60	0,58329	0,42487	0,50408	1,37288	5,40	0,57434	0,38938	0,48186	1,47501	10,4	0,59142	0,45938	0,52540	1,28744
2,70	0,59216	0,45138	0,52177	1,31188	5,50	0,57503	0,39315	0,48409	1,46263	10,6	0,59193	0,46544	0,52869	1,27178
2,74	0,60167	0,47563	0,53865	1,26499	5,60	0,57566	0,39680	0,48623	1,45075	10,8	0,58996	0,46828	0,52912	1,25986
2,77	0,59345	0,45682	0,52513	1,29908	5,70	0,57654	0,40232	0,48943	1,43305	10,9	0,58965	0,47109	0,53037	1,25167
2,80	0,57796	0,41124	0,49460	1,40542	5,80	0,57817	0,41267	0,49542	1,40105	11,0	0,58269	0,46354	0,52312	1,25703
2,85	0,57089	0,47780	0,47435	1,51107	5,85	0,57990	0,42307	0,50149	1,37069	11,1	0,57407	0,45321	0,51364	1,26668
2,90	0,56867	0,35733	0,46300	1,59144	5,90	0,57390	0,40459	0,48924	1,41846	11,2	0,56278	0,43969	0,50124	1,27996
2,95	0,56827	0,34320	0,45574	1,65582	6,00	0,56439	0,37420	0,46929	1,50828	11,3	0,55164	0,42632	0,48898	1,29396
3,00	0,56918	0,32680	0,44799	1,74169	6,04	0,56182	0,36659	0,46420	1,53255	11,4	0,54341	0,41687	0,48014	1,30354
3,02	0,56942	0,32441	0,44692	1,75526	6,10	0,56388	0,36278	0,46333	1,55432	11,5	0,53796	0,40896	0,47391	1,31254
3,07	0,57333	0,30231	0,43782	1,89648	6,20	0,56655	0,35700	0,46178	1,58696	11,6	0,53685	0,40500	0,47093	1,32556
3,10	0,57279	0,30459	0,43869	1,88053	6,30	0,56813	0,36218	0,46516	1,56861	11,7	0,53646	0,39903	0,46774	1,34441
3,16	0,57204	0,30851	0,44027	1,85419	6,40	0,56946	0,36766	0,46856	1,54889	11,8	0,53653	0,39297	0,46475	1,36531
3,20	0,57164	0,31147	0,44156	1,83528	6,50	0,57053	0,37261	0,47157	1,53118	12,0	0,53706	0,38470	0,46088	1,39606
3,30	0,57102	0,32018	0,44560	1,78343	6,60	0,57120	0,37569	0,47344	1,52041	12,5	0,53184	0,35255	0,44219	1,50857
3,40	0,57047	0,32809	0,44928	1,73873	6,70	0,57160	0,37829	0,47495	1,51102	13,0	0,52774	0,32258	0,42516	1,63598
3,50	0,57003	0,33774	0,45389	1,68777	6,80	0,57176	0,37932	0,47554	1,50734	13,5	0,52656	0,30806	0,41731	1,70928
3,60	0,56997	0,34598	0,45798	1,64739	6,90	0,57181	0,37979	0,47580	1,50560	14,0	0,52212	0,29371	0,40791	1,77770
3,70	0,57023	0,35471	0,46247	1,60759	7,00	0,57193	0,38074	0,47634	1,50214	14,5	0,51599	0,27925	0,39762	1,84778
3,80	0,57075	0,36265	0,46670	1,57384	7,20	0,57254	0,38481	0,47867	1,48786	15,0	0,51255	0,27103	0,39179	1,89112

TABLE 12.

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$\varphi = 86^\circ$														
$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\mu$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$
	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	
1,00	0,43182	0,27391	0,35287	1,57653	3,90	0,43019	0,26348	0,34684	1,63274	7,40	0,43234	0,28138	0,35686	1,53649
1,05	0,43190	0,27431	0,35311	1,57447	4,03	0,43048	0,26569	0,34809	1,62021	7,60	0,43269	0,28336	0,35803	1,52700
1,10	0,43197	0,27472	0,35335	1,57241	4,10	0,43053	0,26606	0,34829	1,61816	7,80	0,43318	0,28524	0,35921	1,51862
1,20	0,43205	0,27513	0,35359	1,57035	4,20	0,43062	0,26679	0,34871	1,61406	8,00	0,43339	0,28613	0,35976	1,51462
1,30	0,43221	0,27596	0,35408	1,56623	4,30	0,43066	0,26714	0,34890	1,61210	8,20	0,43371	0,28748	0,36060	1,50864
1,40	0,43113	0,26993	0,35053	1,59721	4,40	0,43068	0,26747	0,34908	1,61019	8,40	0,43392	0,28838	0,36115	1,50469
1,50	0,43246	0,27720	0,35483	1,56007	4,50	0,43069	0,26778	0,34923	1,60838	8,60	0,43448	0,29065	0,36257	1,49486
1,60	0,43263	0,27804	0,35534	1,55597	4,60	0,43075	0,26845	0,34960	1,60455	8,80	0,43517	0,29339	0,36428	1,48323
1,70	0,43272	0,27847	0,35559	1,55392	4,70	0,43079	0,26881	0,34980	1,60257	9,00	0,43611	0,29707	0,36659	1,46803
1,80	0,43299	0,27975	0,35637	1,54778	4,80	0,43092	0,26959	0,35026	1,59839	9,20	0,43754	0,30231	0,36993	1,44734
1,90	0,43327	0,28104	0,35715	1,54166	4,90	0,43107	0,27041	0,35074	1,59412	9,40	0,43891	0,30715	0,37303	1,42900
2,00	0,43376	0,28323	0,35850	1,53148	5,00	0,43130	0,27165	0,35148	1,58771	9,60	0,44065	0,31277	0,37671	1,40887
2,20	0,43498	0,28823	0,36161	1,50918	5,10	0,43161	0,27329	0,35245	1,57929	9,80	0,44256	0,31889	0,38073	1,38782
2,40	0,43724	0,29643	0,36683	1,47503	5,20	0,43201	0,27535	0,35368	1,56892	10,0	0,44514	0,32591	0,38552	1,36583
2,50	0,43896	0,30208	0,37052	1,45314	5,30	0,43258	0,27827	0,35543	1,55457	10,2	0,44720	0,33161	0,38940	1,34858

TABLE 12 (continued)

2,60	0,44129	0,30912	0,37520	1,42756	5,40	0,43312	0,28082	0,35697	1,54234	10,4	0,44876	0,33717	0,39296	1,33096
2,70	0,44939	0,33066	0,39002	1,35906	5,50	0,43376	0,28380	0,35878	1,52840	10,6	0,44923	0,34213	0,39568	1,31304
2,74	0,45812	0,35068	0,40440	1,30638	5,60	0,43434	0,28669	0,36052	1,51501	10,8	0,44745	0,34442	0,39593	1,29916
2,77	0,45058	0,33511	0,39284	1,34456	5,70	0,43515	0,29107	0,36311	1,49503	10,9	0,44717	0,34671	0,39694	1,28974
2,80	0,43647	0,29817	0,36732	1,46383	5,80	0,43666	0,29931	0,36799	1,45888	11,0	0,44087	0,34041	0,39064	1,29513
2,85	0,43001	0,27170	0,35086	1,58262	5,85	0,43826	0,30764	0,37296	1,42456	11,1	0,43314	0,33185	0,38249	1,30522
2,90	0,42792	0,25574	0,34183	1,67324	5,90	0,43283	0,29285	0,36284	1,47800	11,2	0,43310	0,32075	0,37193	1,31909
2,95	0,42748	0,24483	0,33615	1,74604	6,00	0,42429	0,26885	0,34657	1,57821	11,3	0,41329	0,30988	0,36159	1,33370
3,00	0,42815	0,23226	0,33021	1,84342	6,04	0,42201	0,26290	0,34245	1,60518	11,4	0,40611	0,30225	0,35418	1,34359
3,02	0,42835	0,23044	0,32939	1,85883	6,10	0,42378	0,25995	0,34186	1,63022	11,5	0,40137	0,29663	0,34900	1,35311
3,07	0,43160	0,21369	0,32265	2,01975	6,20	0,42607	0,25548	0,34078	1,66772	11,6	0,40042	0,29279	0,34661	1,36764
3,10	0,43115	0,21541	0,32328	2,00154	6,30	0,42748	0,25951	0,34349	1,64728	11,7	0,40009	0,28808	0,34409	1,38880
3,16	0,43052	0,21837	0,32445	1,97150	6,40	0,42868	0,26377	0,34623	1,62521	11,8	0,40016	0,28333	0,34174	1,41233
3,20	0,43019	0,22061	0,32540	1,94999	6,50	0,42965	0,26764	0,34865	1,60535	12,0	0,40061	0,27686	0,33873	1,44700
3,30	0,42971	0,22722	0,32847	1,89113	6,60	0,43026	0,27005	0,35016	1,59327	12,5	0,39606	0,25186	0,32396	1,57253
3,40	0,42928	0,23325	0,33127	1,84041	6,70	0,43064	0,27209	0,35136	1,58270	13,0	0,39248	0,22891	0,31070	1,71452
3,50	0,42897	0,24064	0,33480	1,78262	6,80	0,43078	0,27290	0,35184	1,57856	13,5	0,39143	0,21791	0,30467	1,79630
3,60	0,42897	0,24698	0,33798	1,73689	6,90	0,43083	0,27327	0,35205	1,57660	14,0	0,38764	0,20710	0,29737	1,87173
3,70	0,42926	0,25372	0,34149	1,69188	7,00	0,43094	0,27402	0,35248	1,57269	14,5	0,38245	0,19629	0,28937	1,94840
3,80	0,42978	0,25988	0,34483	1,65375	7,20	0,43151	0,27721	0,35436	1,55660	15,0	0,37955	0,19018	0,28487	1,99580

TABLE 13.

$\varphi = 88^\circ$														
$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$	$\lambda$	Radiation coefficient			$\frac{ \epsilon_{p\lambda} }{ \epsilon_{s\lambda} }$
	$\mu$	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $			$\mu$	$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $			$ \epsilon_{p\lambda} $	$ \epsilon_{s\lambda} $	$ \epsilon_\lambda $	
1,0	0,24580	0,14808	0,19694	1,65664	3,90	0,24468	0,14196	0,19332	1,72359	7,40	0,24617	0,15248	0,19933	1,61438
1,05	0,24585	0,14832	0,19708	1,65761	4,03	0,24488	0,14326	0,19407	1,70939	7,60	0,24641	0,15365	0,20003	1,60364
1,10	0,24590	0,14856	0,19723	1,65528	4,10	0,24492	0,14347	0,19419	1,70706	7,80	0,24673	0,15477	0,20075	1,59418
1,20	0,24595	0,14880	0,19738	1,65295	4,20	0,24498	0,14390	0,19444	1,70242	8,00	0,24687	0,15530	0,20109	1,58967
1,30	0,24606	0,14928	0,19767	1,64830	4,30	0,24500	0,14410	0,19455	1,70019	8,20	0,24709	0,15610	0,20160	1,58291
1,40	0,24533	0,14574	0,19553	1,68334	4,40	0,24502	0,14430	0,19466	1,69802	8,40	0,24724	0,15663	0,20194	1,57845
1,50	0,24623	0,15002	0,19812	1,64133	4,50	0,24503	0,14448	0,19475	1,69596	8,60	0,24762	0,15798	0,20280	1,56735
1,60	0,24635	0,15051	0,19843	1,63669	4,60	0,24507	0,14487	0,19497	1,69161	8,80	0,24808	0,15962	0,20385	1,55421
1,70	0,24640	0,15076	0,19858	1,63438	4,70	0,24510	0,14508	0,19509	1,68936	9,00	0,24872	0,16182	0,20527	1,53704
1,80	0,24659	0,15152	0,19905	1,62744	4,80	0,24518	0,14554	0,19536	1,68463	9,20	0,24969	0,16495	0,20732	1,51367
1,90	0,24678	0,15228	0,19953	1,62052	4,90	0,24529	0,14602	0,19565	1,67980	9,40	0,25061	0,16786	0,20924	1,49296
2,00	0,24711	0,15358	0,20035	1,60901	5,00	0,24545	0,14675	0,19610	1,67256	9,60	0,25179	0,17126	0,21152	1,47024
2,20	0,24794	0,15654	0,20224	1,58383	5,10	0,24566	0,14772	0,19669	1,66304	9,80	0,25308	0,17497	0,21403	1,44645
2,40	0,24946	0,16143	0,20545	1,54530	5,20	0,24592	0,14893	0,19743	1,65131	10,0	0,25483	0,17925	0,21704	1,42167
2,50	0,25063	0,16482	0,20773	1,52062	5,30	0,24632	0,15065	0,19848	1,63508	10,2	0,25623	0,18273	0,21948	1,40219

TABLE 13 (continued)

2,60	0,25220	0,16906	0,21063	1,49180	5,40	0,24668	0,15215	0,19942	1,62126	10,4	0,25729	0,18615	0,22172	1,38217					
2,70	0,25770	0,18217	0,21993	1,41463	5,50	0,24711	0,15392	0,20051	1,60549	10,6	0,25761	0,18920	0,22341	1,36160					
2,74	0,26366	0,19454	0,22910	1,35529	5,60	0,24751	0,15563	0,20157	1,59034	10,8	0,25641	0,19059	0,22350	1,34534					
2,77	0,25851	0,18490	0,22171	1,39813	5,70	0,24806	0,15823	0,20315	1,56770	10,9	0,25622	0,19200	0,22411	1,33445					
2,80	0,24896	0,16247	0,20572	1,53232	5,80	0,24909	0,16316	0,20612	1,52670	11,0	0,25197	0,18807	0,22002	1,33974					
2,85	0,24459	0,14678	0,19569	1,66640	5,85	0,25018	0,16816	0,20917	1,48774	11,1	0,24679	0,18278	0,21479	1,35018					
2,90	0,24316	0,13745	0,19031	1,76905	5,90	0,24653	0,15929	0,20291	1,54771	11,2	0,24013	0,17598	0,20805	1,36452					
2,95	0,24283	0,13114	0,18698	1,85176	6,00	0,24083	0,14509	0,19296	1,65986	11,3	0,23367	0,16937	0,20152	1,37966					
3,00	0,24323	0,12392	0,18358	1,96280	6,04	0,23931	0,14161	0,19046	1,68992	11,4	0,22898	0,16476	0,19687	1,38975					
3,02	0,24335	0,12288	0,18312	1,98041	6,10	0,24046	0,13989	0,19018	1,71888	11,5	0,22591	0,16139	0,19365	1,39976					
3,07	0,24543	0,11337	0,17940	2,16491	6,20	0,24195	0,13730	0,18962	1,76220	11,6	0,22530	0,15911	0,19220	1,41603					
3,10	0,24514	0,11434	0,17974	2,14398	6,30	0,24289	0,13964	0,19126	1,73936	11,7	0,22509	0,15633	0,19071	1,43987					
3,16	0,24474	0,11602	0,18038	2,10951	6,40	0,24369	0,14213	0,19291	1,71458	11,8	0,22513	0,15352	0,18933	1,46646					
3,20	0,24453	0,11729	0,18091	2,08488	6,50	0,24434	0,14439	0,19437	1,69222	12,0	0,22542	0,14971	0,18757	1,50568					
3,30	0,24423	0,12105	0,18264	2,01770	6,60	0,24476	0,14581	0,19528	1,67862	12,5	0,22247	0,13514	0,17880	1,64622					
3,40	0,24397	0,12449	0,18423	1,95980	6,70	0,24501	0,14701	0,19601	1,66667	13,0	0,22014	0,12196	0,17105	1,80500					
3,50	0,24380	0,12873	0,18626	1,89391	6,80	0,24511	0,14748	0,19629	1,66198	13,5	0,21946	0,11571	0,16759	1,89659					
3,60	0,24382	0,13637	0,18810	1,84185	6,90	0,24514	0,14770	0,19642	1,65976	14,0	0,21704	0,10962	0,16333	1,97998					
3,70	0,24404	0,13628	0,19016	1,79069	7,00	0,24522	0,14814	0,19668	1,65532	14,5	0,21374	0,10355	0,15864	2,06400					
3,80	0,24440	0,13986	0,19213	1,74741	7,20	0,24560	0,15002	0,19781	1,63712	15,0	0,21190	0,10015	0,15603	2,11594					

A large part of the absorption bands of liquid water consists of the water vapor band, displaced in the direction of long wavelengths. Consequently they must be attributed to the absorption by free molecules. Some of the bands are characteristic only for liquid water, and the reason for their occurrence is the variation in the energy levels of the water molecules in the condensed state under the influence of adjoining molecules. The bands overlap, producing strong absorption in the entire infrared region of the spectrum.

In accordance with equation (12), the reflection maxima are associated with the absorption bands and are slightly displaced in the direction of longer waves (fig. 2).

Because the experimental data are obtained with limited accuracy, while in practice we are interested in the variation of the radiation coefficient and the reflection coefficient up to 0.01 percent, an assumption is made concerning the absolute accuracy of the data in Table 1. In this case, for all wavelengths and sighting angles the reliability of the results is the same, which makes it possible to carry out a comparison analysis by means of Tables 2-13.

Inasmuch as the coefficient of refraction is a complex quantity, the coefficients of reflection and of radiation will also be complex. This means that the phases are displaced in the reflected light, and it is necessary to determine the squares of the moduli when computing the coefficients by means of equations (7) and (8).

It is necessary to call attention also to one peculiar feature of reflection and radiation which takes place at the Brewster angle (the angle of total polarization  $\varphi_B$ ).

The denominator of expression (3) is always finite except in the case  $\varphi_{B\lambda} + \psi_\lambda = \frac{\pi}{2}$ ,

$$\operatorname{tg}(\varphi_{B\lambda} + \psi_\lambda) = \infty. \quad (15)$$

In the case  $\rho_{p\lambda} \rightarrow 0, \varepsilon_{p\lambda} \rightarrow 1$ .

Because  $\frac{\sin \varphi_{B\lambda}}{\sin \psi_\lambda} = n_\lambda$ , a similar condition exists when  $\sin \varphi_{B\lambda} = n_\lambda \sin \psi_\lambda = n_\lambda \sin\left(\frac{\pi}{2} - \varphi_{B\lambda}\right) = n_\lambda \cos \varphi_{B\lambda}$ , i.e., for

$$\operatorname{tg} \varphi_{B\lambda} = n_\lambda. \quad (16)$$

If the wave is reflected at this angle, then the reflected radiation is polarized in a linear fashion in the plane of incidence. This conclusion is approximate. Although Fresnel equations transmit the results of observations very well, actually, the component of reflected light in the plane of incidence can never be completely extinguished.

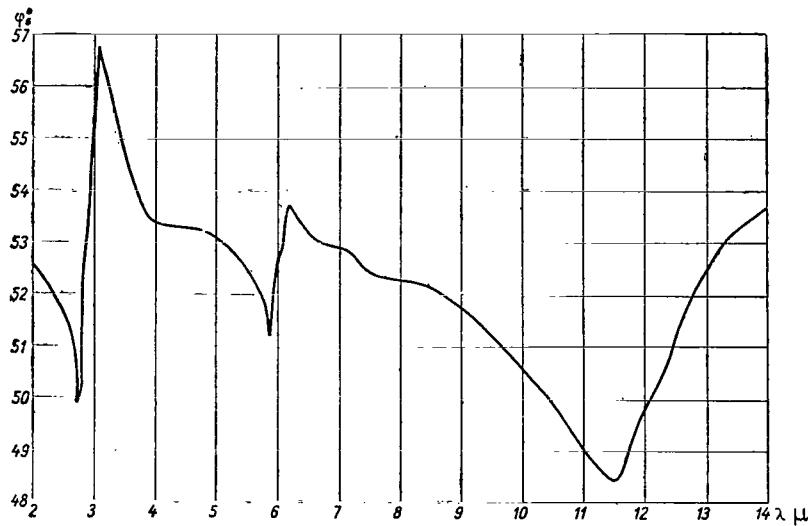


Figure 3. Brewster angle for water in infrared region of spectrum.

Nevertheless, it makes sense to consider the values of the Brewster angle, which are assumed for water, because this is the optimum case for applying polarizing filters (Table 1 and fig. 3).

The p-component of radiation tends to a maximum ( $\epsilon_{p\lambda} \rightarrow 1$ ) and, in any case, is very close to its value for normal sighting. At the same time, the p-component of reflection tends to a minimum ( $\rho_{p\lambda} \rightarrow 0$ ) which provides for a minimum level of radiation distortions and fluctuations.

Consequently, in studying the natural radiation of thermal heterogeneities and the water surface it is most advantageous to operate with the p-component.

For the complex quantities  $\dot{n}_\lambda$  the approximate analogue of the Brewster angle may be determined from the modulus  $n_\lambda$ , although the departure from total polarization in this case is unavoidable.

Since the index of absorption of water in the infrared spectral region is  $\chi_\lambda = \frac{\chi_\lambda}{n_\lambda} < 0.3$  the errors are not too substantial.

We present the method of computing the coefficients of reflection and radiation for complex  $n_\lambda$  (ref. 4).

Let

$$\sin \dot{\psi}_\lambda = \frac{\sin \varphi}{\dot{n}_\lambda}, \quad (17)$$

$$\left. \begin{array}{l} \dot{\psi}_\lambda = \psi_{1\lambda} + j\psi_{2\lambda}, \\ \dot{n}_\lambda = n_\lambda - jx_\lambda. \end{array} \right\} \quad (18)$$

To find the moduli of the complex expressions (3), (4) and (5), it is necessary to carry out a substantial transformation over the volume. Therefore, unless computers are used, it is very difficult to obtain these characteristics.

From equations (17) and (18) it follows that:

$$\sin \psi_\lambda = \sin(\psi_{1\lambda} + j\psi_{2\lambda}) = \sin \psi_{1\lambda} \operatorname{ch} \psi_{2\lambda} + j \cos \psi_{1\lambda} \operatorname{sh} \psi_{2\lambda}. \quad (19)$$

On the other hand,

$$\frac{\sin \varphi}{n_\lambda} = \frac{\sin \varphi}{n_\lambda - jx_\lambda} = \frac{n_\lambda \sin \varphi}{n_\lambda^2 + x_\lambda^2} + j \frac{x_\lambda \sin \varphi}{n_\lambda^2 + x_\lambda^2}. \quad (20)$$

By equating the real and imaginary parts we obtain

$$\sin \psi_{1\lambda} \operatorname{ch} \psi_{2\lambda} = \frac{n_\lambda \sin \varphi}{n_\lambda^2 + x_\lambda^2} = y_\lambda, \quad (21)$$

$$\cos \psi_{1\lambda} \operatorname{sh} \psi_{2\lambda} = \frac{x_\lambda \sin \varphi}{n_\lambda^2 + x_\lambda^2} = z_\lambda, \quad (22)$$

from which

$$\operatorname{sh} \psi_{2\lambda} = \frac{z_\lambda}{\cos \psi_{1\lambda}} \quad (23)$$

and

$$\operatorname{ch} \psi_{2\lambda} = \sqrt{1 + \operatorname{sh}^2 \psi_{2\lambda}} = \sqrt{1 + \frac{z_\lambda^2}{\cos^2 \psi_{1\lambda}}}, \quad (24)$$

$$\sin \psi_{1\lambda} = \frac{y_\lambda}{\operatorname{ch} \psi_{2\lambda}} = \frac{y_\lambda}{\sqrt{1 + \frac{z_\lambda^2}{\cos^2 \psi_{1\lambda}}}} = \frac{y_\lambda}{\sqrt{1 + \frac{z_\lambda^2}{1 - \sin^2 \psi_{1\lambda}}}}. \quad (25)$$

Solving equation (25) with respect to  $\sin \psi_{1\lambda}$ , we obtain

$$\sin^4 \psi_{1\lambda} - (1 + y_\lambda^2 + z_\lambda^2) \sin^2 \psi_{1\lambda} + y_\lambda^2 = 0, \quad (26)$$

$$\sin \psi_{1\lambda} = \sqrt{\frac{1 + y_\lambda^2 + z_\lambda^2 - \sqrt{(1 + y_\lambda^2 + z_\lambda^2)^2 - 4y_\lambda^2}}{2}} = A_\lambda \quad (27)$$

(only the positive solution  $0 < \sin \psi_1 < 1$  is of interest)

$$\psi_{1\lambda} = \arcsin A_\lambda. \quad (28)$$

$\psi_{2\lambda}$  is determined from the known value of  $\psi_{1\lambda}$  and from equation (23):

$$\operatorname{sh} \psi_{2\lambda} = \frac{z_\lambda}{\cos \psi_{1\lambda}} = \frac{z_\lambda}{\sqrt{1 - A_\lambda^2}} = B_\lambda, \quad (29)$$

$$\psi_{2\lambda} = \operatorname{Arsh} B_\lambda = \ln(B_\lambda + \sqrt{B_\lambda^2 + 1}). \quad (30)$$

Let us also introduce the designations

$$\varphi - \dot{\psi}_\lambda = \varphi - \psi_{1\lambda} - j\psi_{2\lambda} = \xi_\lambda - j\psi_{2\lambda}, \quad (31)$$

$$\varphi + \dot{\psi}_\lambda = \varphi + \psi_{1\lambda} + j\psi_{2\lambda} = \theta_\lambda + j\psi_{2\lambda}. \quad (32)$$

Then

$$\operatorname{tg}(\xi_\lambda - j\psi_{2\lambda}) = \frac{\sin 2\xi_\lambda}{\cos 2\xi_\lambda + \operatorname{ch} 2\psi_{2\lambda}} - j \frac{\operatorname{sh} 2\psi_{2\lambda}}{\cos 2\xi_\lambda + \operatorname{ch} 2\psi_{2\lambda}} = M_{p\lambda} - jN_{p\lambda}, \quad (33)$$

$$\begin{aligned} \operatorname{tg}(\theta_\lambda + j\psi_{2\lambda}) &= \frac{\sin 2\theta_\lambda}{\cos 2\theta_\lambda + \operatorname{ch} 2\psi_{2\lambda}} + j \frac{\operatorname{sh} 2\psi_{2\lambda}}{\cos 2\theta_\lambda + \operatorname{ch} 2\psi_{2\lambda}} = \\ &= M'_{p\lambda} + jN'_{p\lambda}, \end{aligned} \quad (34)$$

$$\sin(\xi_\lambda - j\psi_{2\lambda}) = \sin \xi_\lambda \operatorname{ch} \psi_{2\lambda} - j \cos \xi_\lambda \operatorname{sh} \psi_{2\lambda} = M_{s\lambda} - jN_{s\lambda}, \quad (35)$$

$$\sin(\theta_\lambda + j\psi_{2\lambda}) = \sin \theta_\lambda \operatorname{ch} \psi_{2\lambda} + j \cos \theta_\lambda \operatorname{sh} \psi_{2\lambda} = M'_{s\lambda} + jN'_{s\lambda}, \quad (35)$$

$$\operatorname{tg}(\xi_\lambda - j\psi_{2\lambda}) = \frac{M_{p\lambda} - jN_{p\lambda}}{M_{p\lambda} + jN'_{p\lambda}} = \frac{M_{p\lambda} M'_{p\lambda} - N_{p\lambda} N'_{p\lambda}}{M_{p\lambda}^2 + N_{p\lambda}^2} - \quad (36)$$

$$- j \frac{M'_{p\lambda} N_{p\lambda} + M_{p\lambda} N'_{p\lambda}}{M_{p\lambda}^2 + N_{p\lambda}^2} = D_{p\lambda} - jD'_{p\lambda}, \quad (37)$$

$$\dot{\rho}_{p\lambda} = (D_{p\lambda} - jD'_{p\lambda})^2 = D_{p\lambda}^2 - D'^2_{p\lambda} - j2D_{p\lambda}D'_{p\lambda}. \quad (38)$$

To solve practical problems the moduli  $\rho$  and  $\epsilon$  are of principal interest as the characteristics of the energy interaction of matter and radiation

$$|\dot{\rho}_{p\lambda}| = \rho_{p\lambda} = [(D_{p\lambda}^2 - D'^2_{p\lambda})^2 + 4D_{p\lambda}^2 D'^2_{p\lambda}]^{1/2} = D_{p\lambda}^2 + D'^2_{p\lambda}, \quad (39)$$

$$\begin{aligned} \frac{\sin(\xi_\lambda - j\psi_{2\lambda})}{\sin(\theta_\lambda + j\psi_{2\lambda})} &= \frac{M_{s\lambda} - jN_{s\lambda}}{M'_{s\lambda} + jN'_{s\lambda}} = \frac{M_{s\lambda} M'_{s\lambda} - N_{s\lambda} N'_{s\lambda}}{M_{s\lambda}^2 + N_{s\lambda}^2} - \\ &- j \frac{M'_{s\lambda} N_{s\lambda} + M_{s\lambda} N'_{s\lambda}}{M_{s\lambda}^2 + N_{s\lambda}^2} = D_{s\lambda} - jD'_{s\lambda}, \end{aligned} \quad (40)$$

$$\dot{\rho}_{s\lambda} = (D_{s\lambda} - jD'_{s\lambda})^2 = D_{s\lambda}^2 - D'^2_{s\lambda} - j2D_{s\lambda}D'_{s\lambda}, \quad (41)$$

$$|\dot{\rho}_{s\lambda}| = \rho_{s\lambda} = D_{s\lambda}^2 + D'^2_{s\lambda}, \quad (42)$$

$$\rho_\lambda = \frac{1}{2} (\rho_{p\lambda} + \rho_{s\lambda}) = \frac{1}{2} (D_{p\lambda}^2 + D'^2_{p\lambda} + D_{s\lambda}^2 + D'^2_{s\lambda}). \quad (43)$$

Consequently,

$$\epsilon_{p\lambda} = 1 - \rho_{p\lambda}, \quad (44)$$

$$\epsilon_{s\lambda} = 1 - \rho_{s\lambda}, \quad (45)$$

$$\epsilon_\lambda = 1 - \rho_\lambda. \quad (46)$$

Equations (39), (42), (43), (44), (45), and (46) simultaneously express the variation with the angle of incidence (angle of sighting)  $\varphi$ .

By applying the above procedure and utilizing the "Ural" computer we computed  $|\epsilon_{p\lambda}|$ ,  $|\epsilon_{s\lambda}|$ ,  $|\epsilon_\lambda|$ ,  $\frac{|\epsilon_{p\lambda}|}{|\epsilon_{s\lambda}|}$  for fixed values of  $\varphi$  equal to 0, 10, 20, 30, 40, 50, 60, 70, 80, 82, 84, 86, 88 in the region of wavelengths from  $1-15 \mu$  using non-uniform steps (according to the steps in Table 1).

The results of the calculations are shown in Tables 2-13 and are illustrated by figures 4-8, which show the variation both to a linear scale and a scale which has been functionally extended (the probability scale).

The analysis of these data as well as the analysis of the quantities  $\rho_\lambda$

makes it possible to clarify a whole series of interesting features associated with the radiation of a water surface. We should point out that in addition to the natural radiation, the mirror and scattered reflection at the water surface by part of the sky, by heavenly bodies, etc. is also important in a series of cases.

The analysis of this question is quite difficult because of the many different possible cases, and must therefore be limited.

The s-component of radiation undergoes a maximum change as the sighting angle increases.

The nonpolarized radiation is fairly stable from 0 to  $40^\circ$  and then the emissive power begins to decrease very rapidly.

The p-component of radiation increases up to the Brewster angle ( $\epsilon_p = 1$ ),

and then begins to decrease, but at a slower rate than for the nonpolarized flux or for the s-component.

Within the limits of the sighting angles from 0 to  $60-70^\circ$  the variations in the p-component are minimum. In addition, because  $\epsilon_p \rightarrow 1$  for  $\varphi = \varphi_B$ , there is a minimum reflected radiation for the p-component. It is especially important that the p-component remain practically unchanged in the region  $\varphi_B \pm (10-15)^\circ$  (figs. 4 and 5).

The spectral variation in the curves for  $\epsilon_\lambda$ ,  $\epsilon_{p\lambda}$ ,  $\epsilon_{s\lambda}$  is characterized by extreme points, which basically correspond to the analogous maxima and minima

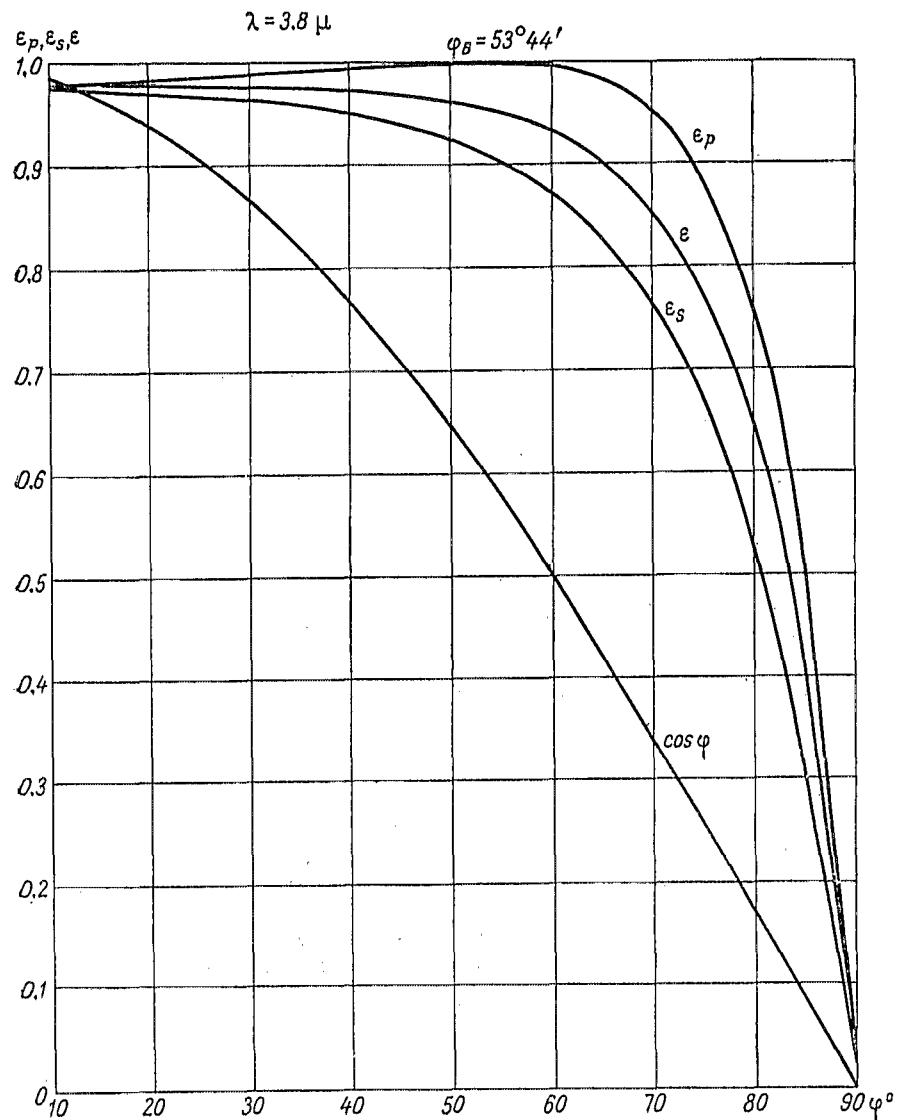


Figure 4. Example of variation in spectral radiation coefficient ( $\lambda = 3.8 \mu$ ) with various sighting angles.

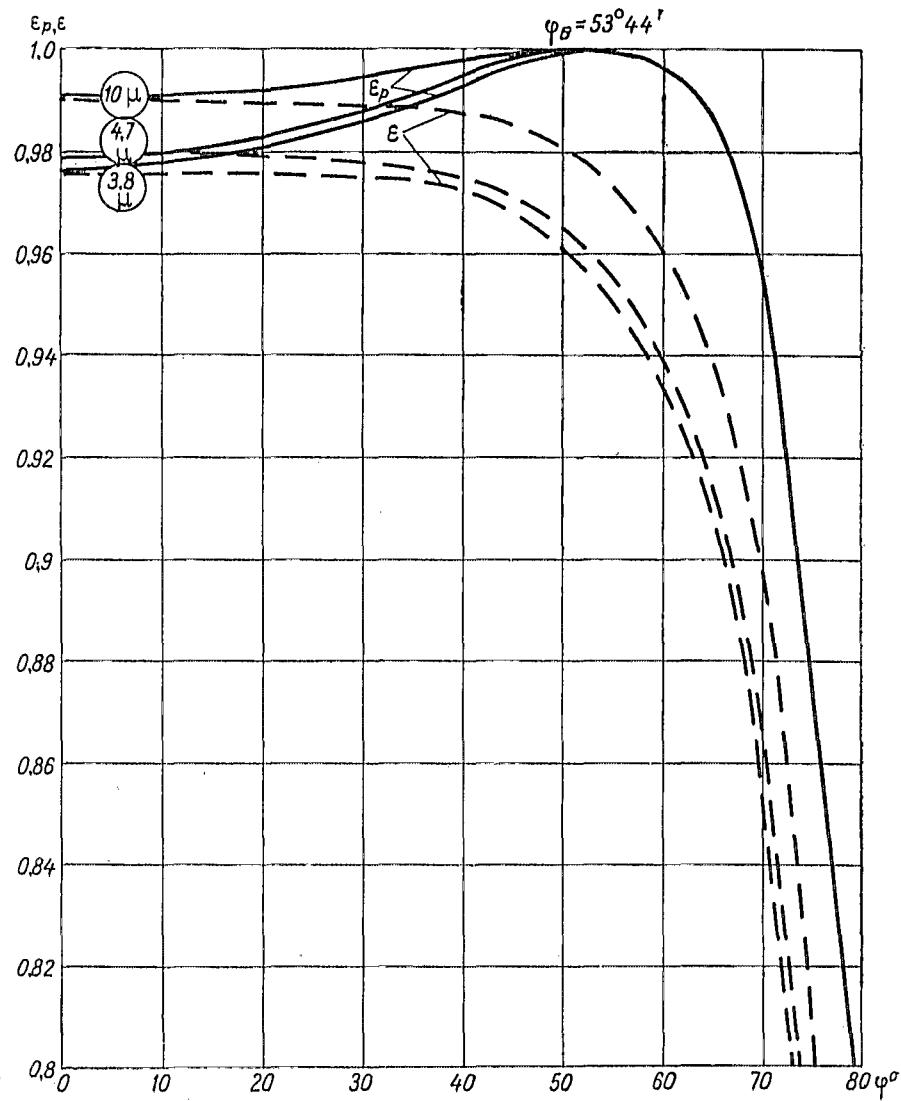


Figure 5. Variation in radiation coefficient and in  $p$ -component of polarization with different sighting angles for  $\lambda$  equal to  $3.8$ ,  $4.7$  and  $10 \mu$ .

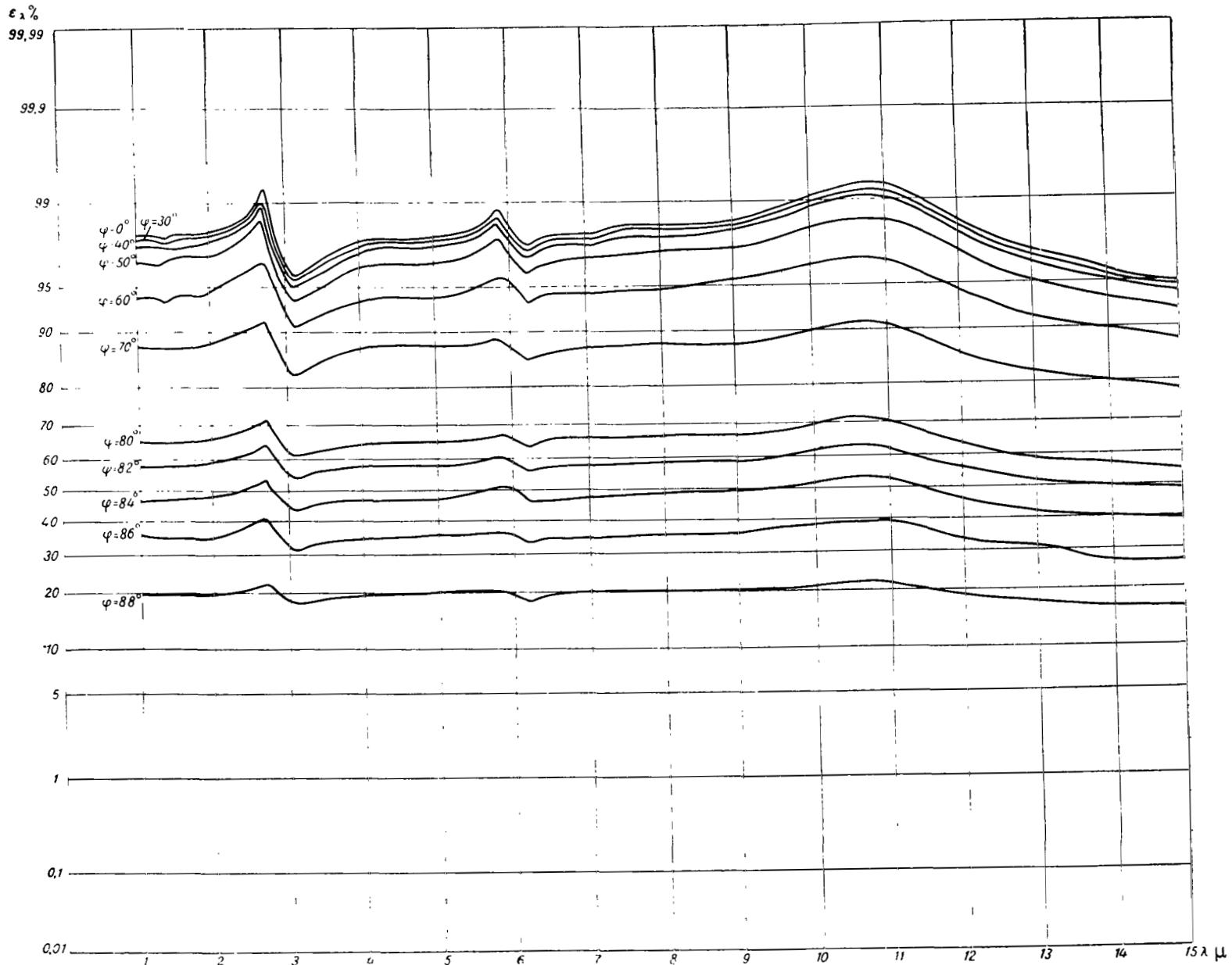


Figure 6. Spectral radiation coefficient for natural polarization.

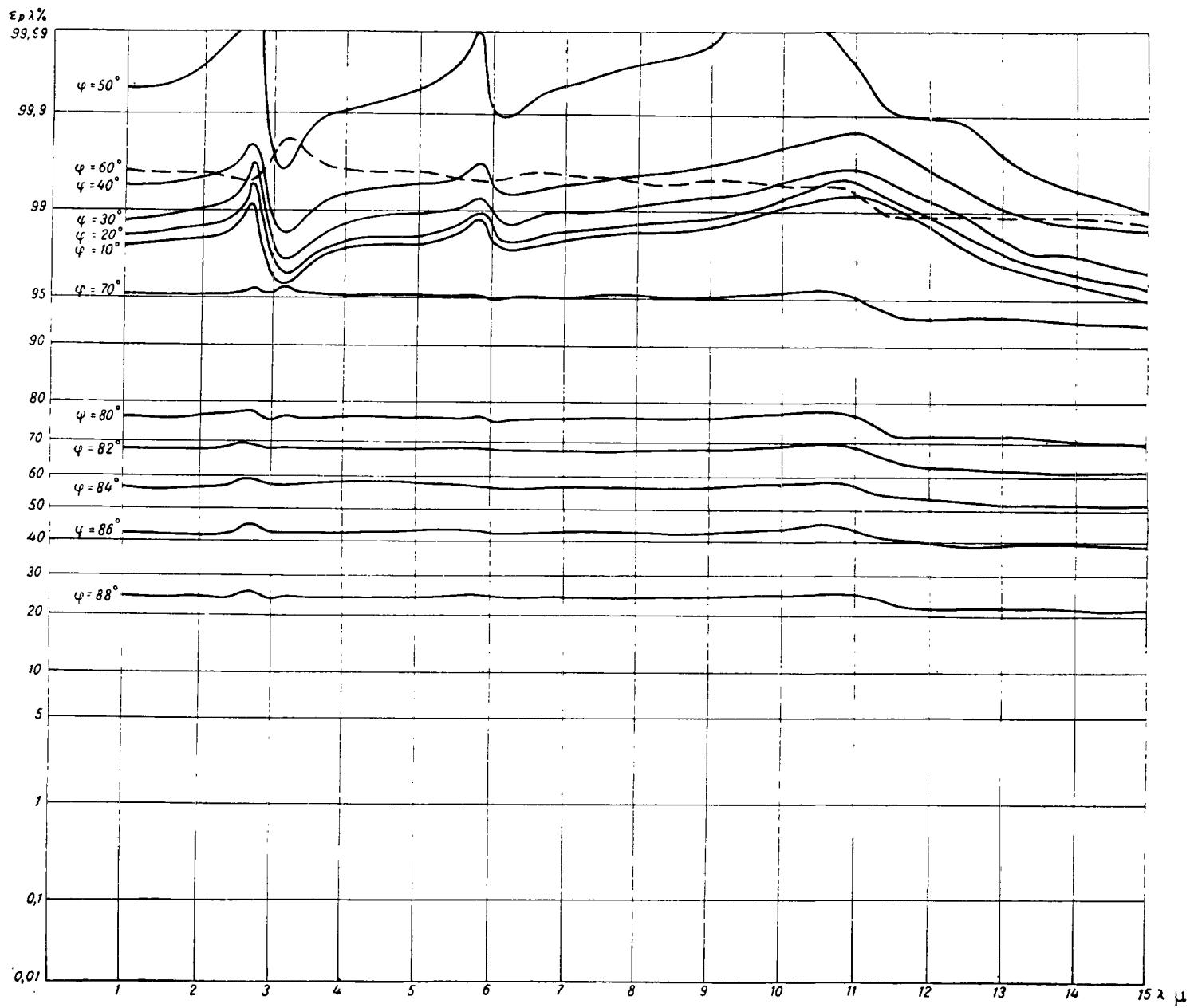


Figure 7. p-component of spectral coefficient of radiation.

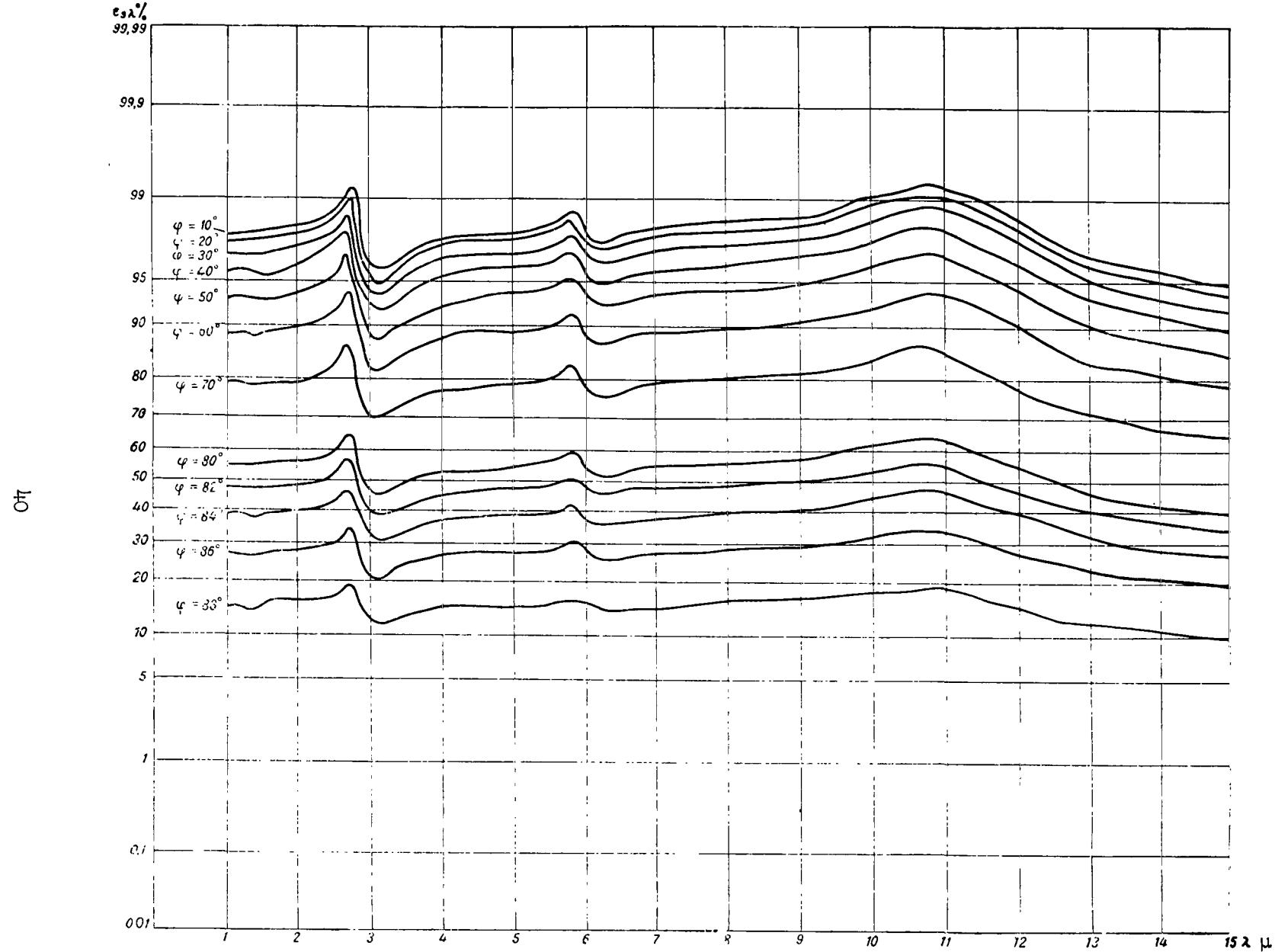


Figure 8. s-component of spectral coefficient of radiation.

of the curves for  $n_\lambda$  and  $\kappa_\lambda$  (fig. 1). However, the extreme values are not as pronounced, particularly when the sighting angles are  $\varphi > 80^\circ$ .

The most substantial variations are exhibited by the spectral characteristics of the p-component near the Brewster angles ( $\varphi = 50$  to  $60^\circ$ ). Because the Brewster angle is also a selective characteristic (fig. 3) we have  $\epsilon_{p\lambda} = 1$  for various values of the angle  $\varphi$ . The laws governing the variation of the spectral curves, therefore, are disrupted, and additional maxima and minima appear on the curves  $\varphi = 50^\circ$  and  $\varphi = 60^\circ$  (figs. 6-8).

Since the purpose of the present article is to present in detail all the initial data on the emissive power of water, the performance of a more detailed analysis applicable to specific engineering and physical problems is outside the scope of the present work.

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